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A General-Equilibrium- Based Social Policy Model for Côte d'Ivoire

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A useful social policy framework that can generate rich inputs to
the Ivorian policy process.

This paper — a product of the Poverty and Social Policy Division — Africa Technical Department — is part of a larger effort in the region to develop poverty-conscious macroeconomic frameworks in Sub-Saharan Africa. Copies of the paper are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Audrey Cox, room J2-264, extension 34778 (June 1992, 88 pages).

This paper reports on a general-equilibrium-based social policy model for Côte d'Ivoire — its structure, the data used in its implementation, and its application to the analysis of tax incidence and antipoverty programs.

The authors emphasize that special features of the Ivorian economy and tax system are central to any assessment of the distribution consequences of tax policies and other social policies in Côte d'Ivoire. Because the bases of individual taxes tend to be narrow — the incidence effects by socioeconomic group are pronounced, while those by income range are milder. Urban employees are largely affected by income taxes (through withholding). Export food croppers are affected by the stabilization fund and export taxes. In addition, large interhousehold transfers in Côte d'Ivoire give incidence profiles that differ from conventional analysis. The reason: the taxes seemingly borne by one household group have second-round effects on other household groups through changed interhousehold transfers.

For the targeted antipoverty programs, the authors show that when general equilibrium effects are taken into account, it is impossible under a budget-neutral targeting program to completely eliminate poverty (as traditional analysis would suggest). At the same time, small transfers generally have a greater relative effect than larger targeting programs. This has several policy implications for the cost of the programs and the choice of groups that should benefit. As in the tax incidence analysis, the authors show that such domestic features as interhousehold transfers play an important role in determining the final outcome of the targeting program.

The model should be seen as an instrument that helps in developing capacities for macroanalysis and in generally enhancing the economic debate. It should be transparent enough to enable policymakers to use it efficiently — and at the same time answer some key questions of relevance to the Ivorian economy.

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by

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I. INTRODUCTION AND OBJECTIVES

This paper describes a general equilibrium based social policy model for Côte d'Ivoire whose aim is both to facilitate analyses of a wide range of social policy options, any of which could conceivably be pursued in Côte d'Ivoire over the next five or ten years, and to provide a basis for further model development to cover explicit monetary, macro, and stabilization issues which are central to current Ivorian policy debate. As it now stands, the model is a classical real side general equilibrium model in the public finance tradition (Harberger 1962, Shoven and Whalley 1984), modified to capture such key Ivorian features as domestic price stabilization schemes, large interhousehold transfers, the informal sector, and other features.¹ The model allows for detailed analysis of social policy options such as impacts of anti-poverty programs, but embeds such analyses within a general equilibrium framework. This also captures relative price effects, financing implications, resource allocation and other economy-wide effects missing in existing work on targeting policies. Hence the description of our social policy model as general equilibrium-based.

The model captures some of the more major interactions between key sectors of the Ivorian economy: modern and traditional, urban and rural, agricultural and manufacturing, importing and exporting, formal and informal, and others. Its strength is its capability to trace through the economy-wide implications of any proposed policy changes. It can identify which sectors may expand and which contract; which groups in the economy may gain or lose; and assess impacts on trade patterns and inter-sectoral resource transfers. Its weakness

¹ Plans exist to extend the model to allow evaluation of Ivorian participation in the Franc Zone, deficit reduction and stabilization programs, and other issues not captured by the present structure.

is its traditional equilibrium structure which assumes competitive behavior, incorporates no explicit treatment of time and in its present form, contains no monetary features and has balanced government and external sector accounts.² It uses data from a 1986 Social Accounting Matrix (SAM) constructed by a modelling group in Côte d'Ivoire; part of the newly created macro-economic unit at the Ecole Nationale de Statistique et d'Economie Appliquée (ENSEA).³

In the text, we describe the model structure,⁴ and illustrate its application to social policy design in Côte d'Ivoire by presenting model-based analyses of tax incidence in Côte d'Ivoire and the design of anti-poverty programs. For policy changes in each of these categories, we solve the model for a range of possible policy changes, and compare model results with base-case data. These results show both how key features of the Ivorian economy (such as large interhousehold transfers) need to be taken into account in analyzing the impacts of possible new social policies in Côte d'Ivoire, and how important general equilibrium considerations can be in such analyses.

The paper is divided into 5 sections. Section 2 describes the model in detail; Sections 3 and 4 present examples of its application, first with analysis of tax incidence in Côte d'Ivoire, and second with evaluation of anti-poverty programs. A concluding section summarizes work thus far with the model, and plots a path for the future.

² Hence the impacts of international debt renegotiations for Côte d'Ivoire could not be adequately addressed through the present modelling framework.

³ For more details on the institutional setting within which the model has been developed and is planned to operate in the future, see Wahba and Whalley (1992).

⁴ Appendices A and B present a formal description of the model and the input data used (including elasticity and other parameter values).

II. GENERAL EQUILIBRIUM-BASED SOCIAL POLICY ANALYSIS FOR CÔTE D'IVOIRE

The Côte d'Ivoire Economy

Côte d'Ivoire is a mid-sized African economy with a population of 12 million (1989) and income *per capita* of approximately \$740 (1990). It is one of the key member countries of West African Monetary Union (Union monétaire Ouest-Africaine-UMOA)⁵ that share a common freely convertible currency. Côte d'Ivoire accounts for 41 percent of the Union's GDP and 23 percent of the total population.

In the first two decades following independence, the Ivorian economy experienced strong economic performance, with rapid growth in both output and exports. The average annual growth rate of GDP for the period 1965-1973 was 8.9 percent. But in the second half of the seventies, a series of shocks disrupted the economy. These began with a coffee price boom in 1976, following which revenues accruing to the government through the Stabilization Fund that regulates domestic coffee and cocoa prices received by producers were committed to finance a major investment program. Although world prices fell immediately after 1976, the government continued its investment program into the early 1980s in the belief that the fall in world prices was temporary. But commodity prices continued to fall sharply, growth in the Ivorian economy slowed (and turned negative), and debt service became a major problem. By 1981, the budget deficit had reached 12 percent of GDP (Chamley (1991)), by 1986 the terms of trade had fallen by 40 percent, and by 1990

⁵ The UMOA includes six other countries, Bénin, Burkina-Faso, Mali, Niger, Sénégal and Togo.

the country's external and internal outstanding debt had reached 125 percent and 37 percent of GDP respectively.

A series of structural adjustment programs in response to these developments were implemented by the government, beginning in the early 1980s. Although there was an improvement in performance between 1984-1986, due to a rise in world prices of coffee and cocoa and an appreciation of the dollar, since 1986 earlier declines in real output have continued, with real GDP falling by more than a quarter. Along with this deterioration in economic performance, government revenues have also steadily fallen as a percentage of GDP from 31.1 percent in 1984 to 23.6 percent in 1990, with this fall mainly reflecting declining Commodity Stabilization Fund revenues. Coffee and cocoa are no longer the majority share in exports, although in 1990 they still accounted for 35 percent of total exports of goods and services.

Applied General Equilibrium Models

The general equilibrium-based social policy model we present here is primarily aimed at aiding assessment of the social consequences of the adjustment programs pursued in Côte d'Ivoire since 1981. It captures relative product- and factor-price movements, and shows how resources reallocate as policies change. Because the model utilizes a base-year Social Accounting Matrices (SAM), which details how incomes generated by production activities are mapped across to households and how expenditure decisions by households are allocated

to sectors, the model explicitly focuses on incomes, their distribution, and how social policies affect the outcome of the economy.⁶

In general equilibrium models, producing units are represented as purchasing inputs from households, and generating value-added by using them in the production process. In return for supplying factor services, households receive income payments, which are, in turn, allocated to savings and consumption. These production and consumption decisions yield supplies and demands in the various product and factor markets. These are made mutually consistent through relative price adjustments, which, unless some rigidity is assumed to exist, in equilibrium yield zero excess demands in all markets. Demands and supplies of agents thus depend on relative prices. Such models also usually explicitly treat the external sector, and hence can also be used to analyze the social impacts of alternative trade policies.

By changing internal social policies (fiscal and expenditure policies, agricultural pricing policies, or labor migration policies, for example) or external sector policies (such as export tax policies, import policies and exchange rate policies), the government in these models can change the behavior of agents. These changes, in turn, will have other general equilibrium effects including on prices. These models, therefore, seek to trace the operation of the underlying real economy. They yield predictions of what is likely to happen to relative product and factor prices if the assumptions of the model, or if policy instruments

⁶ For a summary of the main features of other numerical general equilibrium models to which ours is closely related, see Dervis et al. (1982) Ch.5. See Robinson (1989) for a more recent review of models applied to developing countries. Decaluwé and Martens (1988), and Devarajan (1986) provide helpful bibliographies of the area, and Shoven and Whalley (1984, 1992) an expository introduction to tax-based general equilibrium models.

change. They represent an attempt at empirical application of orthodox real-economy micro theory, typically describing barter rather than monetized representations of actual economies.

The present general equilibrium model has two clearly apparent and major weaknesses in its application to Côte d'Ivoire. The first is that it does not capture macro imbalances; government budget deficits, trade deficits, unemployment, and especially the key monetary components of such imbalances. The second is that it only traces through the effects of social policy interventions on markets, and does not explicitly treat effects on infrastructure and wider social development, including education and health care.

The first weakness is a reflection of the feature that most existing numerical general equilibrium models use fairly simple theoretical structures. In following a classical relative price/barter form, the present model is not able to trace through the effects of macro-economic policies, especially when such policy interventions occur through the operation of monetary variables.⁷ The price level has no real effects, and commodity prices are simply expressed in terms of some numeraire.

⁷ Bourguignon, Branson, and de Melo (1989), and Bourguignon, de Melo and Suwa (1991) have made recent contributions to this area. Their modification of the traditional general equilibrium approach involves the addition of a macro-economic model to the general equilibrium framework, in which the macro-economic sub-model yields the level of *aggregate demand* in the economy (through a variant of an IS/LM system), whilst the general equilibrium sub-model computes the real-side economy, yielding *aggregate supply*. The price level is given by the relation between aggregate supply and demand. Their macro-model contains asset-market equilibrium conditions, which determine a vector of rates of return. These in turn influence the level of aggregate demand. Whether these models provide an empirically convincing description of how macro-economic changes influence the real economy in developing countries is a topic of some discussion. See also the special issue of *World Development*, Vol.19, No.11, November 1991.

The second weakness of the model, especially important for the analysis of social adjustments accompanying policy changes, is its inability to capture the full effects of infrastructural changes. If structural adjustment involves cuts in government expenditures on education, health or public works, there will be income losses for those employed in sectors which previously benefitted from these expenditures (i.e., teachers, doctors, road construction firms, and so on). Expenditure cuts, however, also have indirect effects on households who also previously benefitted from infrastructural services. Cuts in education expenditures not only reduce the incomes of those employed in the education sector, they also adversely affect the education of those who benefitted from the services, reducing current levels of household welfare, and future levels of income. The same can be said for cuts in health expenditure. Reductions in other infrastructural services, such as road construction, have similar effects. Households who as a result cannot gain access to markets and infrastructure inputs will experience declines in output, income, and welfare and these effects of infrastructure changes are not easily captured in the numerical general equilibrium model we use.

Thus, the direct-income effects of social policy-related expenditure cuts are captured in the present model with the resulting contraction in sectoral demands⁸. To analyze these effects, cuts in government expenditure items need to be translated into changed sectoral

⁸ A SAM-based analysis can provide similar assessments, although without general equilibrium effects captured. Thorbecke et al. (1990), for instance, trace the primary-income distribution effects of alternative fiscal policies in Indonesia using a fix-price SAM multiplier model.

demands, so that they can provide readable input into the model (via the SAM). But, indirect effects through reduced provision of social services are not captured.⁹

Model Structure

The model of Côte d'Ivoire contains 15 sectors, and has 7 tradable sectors and 8 non-tradable sectors. Its distinguishing feature, relative to earlier general equilibrium models of Côte d'Ivoire¹⁰, is an explicit focus on social dimensions of economic policies; impacts of policy changes on socio-economic groups, analysis of anti-poverty programs, incidence effects of tax subsidy programs. The model also separately identifies formal and informal sectors of the economy; a departure from previous work.¹¹

Tradable sectors in the model include: the agricultural sector, the traditional export sector, the non-traditional export sector, the first transformation sector (formal and informal), and the manufacturing (formal and informal) industries. Non-tradable sectors include: gas and electricity, construction (formal and informal), transport, financial services, other services (formal and informal) and government services. Given the importance of agriculture in Côte d'Ivoire, considerable detail is incorporated in the model for the agricultural sector. We disaggregate this sector into the food crop sector, the traditional export sector (which include coffee and cocoa) and the non-traditional sector (e.g. sugar,

⁹ For more details see Demery, Noël and Wahba (1991).

¹⁰ The first model of this type for Côte d'Ivoire was used for the preparation of the third Structural Adjustment Loan. See Michel and Noël (1984a,b) and World Bank (1987).

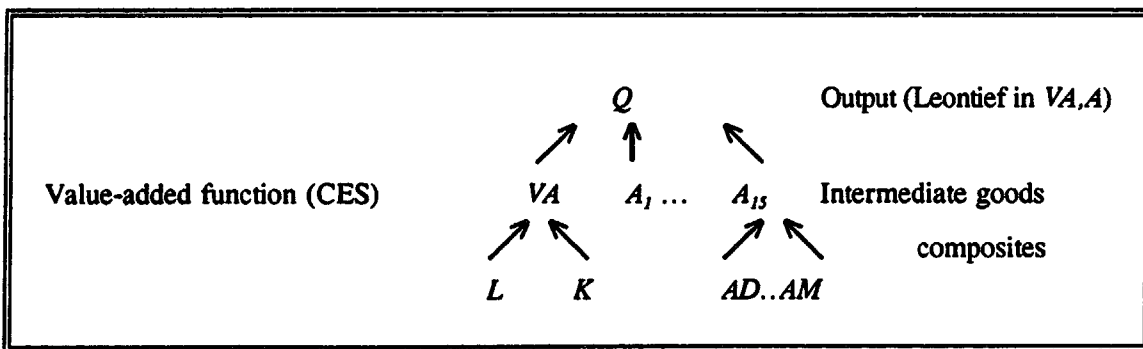
¹¹ For more details on the informal sector, see Chia et al. (1991a). Lambert, Schneider and Suwa (1991) also model the informal sector although it is represented as one sector only.

palm oil, rubber). Within the tradable goods sector, there are four importable and three exportable sectors. The exportable sector covers all goods that are supplied to both the domestic market and as exports.

Production Structure

Production functions in the model are of the nested constant elasticity of substitution (CES) form, and are constant returns to scale, although two special cases of the CES form, Leontief (fixed coefficient) and Cobb-Douglas, are also used. Both traded and non-traded goods are treated as produced by each of these sectors using both primary factors and intermediate inputs. Primary factors include labor, capital, and sector-specific factor. Intermediate inputs are a composite of comparable domestically produced and imported goods (domestic and foreign machinery, for instance).

Figure 1. Nesting Structure of Production Functions used in Each Sector



Demand Structure

Seven household types grouped by socio-economic status are identified in the model. These are households in the traditional export sectors (MEXP), households in Savannah (MSAV), households in agricultural sectors other than in the Savannah (MVIVA), government households (MADP), households in the formal sector (MFOR), independent and self-employed households in the informal sector (MIND), and inactive households (MINAC). Table 1 lists the seven groups, along with data showing the key characteristics of each group, including shares of population, per household income, savings rates, and net transfers paid or received. Classifying households in this way allows the model to identify the impacts of alternative social policies on targeted segments of the economy in ways not possible if households are classified by income level.¹²

¹² The disaggregation of the household sector should be general enough to cover a series of issues other than those examined in the paper. At the same time, it should be representative of the various groups adopted to obtain a distinct inter-household distribution while having homogenous groups. See Dervis, de Melo and Robinson (1989) and The World Bank (1990a).

Table 1

**Characteristics of Household Groups Identified
in the Côte d'Ivoire Social Policy Model**

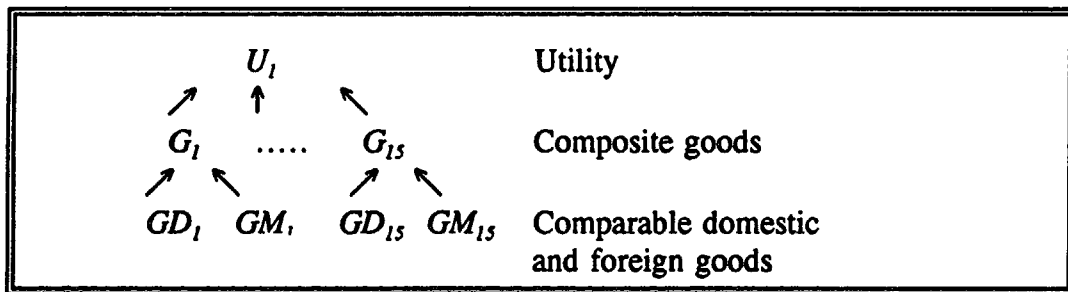
Household Types	Population Share	Poverty ^a index (%)	Per capita income (CFA)	Savings as % of total income	Income tax as % of total income	Transfer payments to other households (as % of total income)	Transfer income received from other households (as % of total income)
Food croppers in Savannah (MSAV)	11.03	63.68	132,972	0.33	0.60	0.0	24.00
Export croppers (MEXP)	20.28	44.04	173,722	0.57	0.50	15.60	0.00
Small businesses (MIND)	21.48	46.81	187,600	0.91	1.00	0.00	3.50
Other food croppers (MVIVA)	12.77	34.46	202,176	0.37	0.55	32.75	0.00
Inactive (MINAC)	15.10	37.07	220,629	0.75	2.81	0.00	67.86
Government employees (MADP)	11.80	8.69	423,085	0.89	5.86	11.24	0.00
Households in formal sector (MFOR)	7.60	1.79	622,807	0.80	2.48	16.96	0.00

^a Percentage of households in the group below the poverty line, based on a poverty line of CFA 140,000 (or 50 percent of mean income for 1986).

Final demands for each of the household groups are generated by maximizing a nested constant elasticity of substitution (CES) utility function subject to the household budget constraint. Figure 2 provides a schematic representation of the nesting structure used in the household utility function. In the top level of the nest, the utility function is specified

as Cobb-Douglas defined over composites of domestic and comparable imported consumption goods. In the lower nest, imports and comparable domestically produced goods are CES functions with different elasticities of substitution for each product. Because we use a static single-period model, the shares of household post-tax income devoted to consumption and savings are assumed to be constant. All household savings are treated as being paid into a savings pool, which finances domestic investment.

Figure 2: Nesting structure used in household utility function



Each household is endowed with a fixed amount of both mobile (labor and capital) and sector-specific factors, has preferences (which differ by household), and consumes the 15 consumer goods identified in the model. Besides income from endowments, households also receive transfers from the government, as well as transfers from abroad and from other

households. As Table 1 indicates, interhousehold transfers¹³ play a major role in the economy, unlike in comparable models of developing countries, resulting in a strong rural-urban income linkage in this model.

Treatment of the Labor Market

The model includes a treatment of the labor market which is more detailed than in other general equilibrium models of developing countries. To capture Côte d'Ivoire labor market segmentation, labor is disaggregated into three types: agricultural, skilled and unskilled labor. Skilled and unskilled labor move freely across sectors, while agricultural labor is sector specific. In the agricultural sector, there are two levels of nesting. The top nest is a CES function of skilled and composite labor. At the lower level of nesting, composite labor is a function of unskilled labor and agricultural labor. In the non-agricultural formal sectors, labor is a nested CES function only of skilled labor and unskilled labor. The informal sector uses only unskilled labor. Treating unskilled and skilled labor as mobile across sectors allows us to capture movements of labor between formal and informal sectors, as well as between agricultural and non-agricultural sectors (i.e. rural-urban migration).¹⁴

¹³ These are estimated using household data on financial savings to which regression estimates on acquisition of financial assets are applied. The difference is taken to be net transfers, which are constrained to sum to zero across all household groups. See Chia et al. (1991) for more detail on the data and to evaluate interhousehold transfers. Pyatt and Round (1984) adopt a similar treatment in estimating interhousehold transfers for Malaysia.

¹⁴ For a more detailed description of the resulting treatment of labour income in the model data set, see Chia et al. (1991).

Capital is treated in the model as reflecting both a fixed sector-specific component, and a component which is mobile across sectors. This treatment is adopted, in part, to avoid any problems with specialization, given the internationally homogeneous good treatment on the export side (see below). Varying the share parameters on fixed and mobile factors in production can also be used to change implied output supply elasticities.

Government Sector

The government sector in the model provides government services, such as public administration, economic and social planning, defence and security services. These services are in reality provided to the public either freely or with a small user fee. In the model they are decided upon through government utility maximization defined over goods used to provide government services; i.e., there is no mechanism for households to articulate demands for public goods. In addition to real goods and services used by government to provide public services, public sector transfers to households for education and other objectives also enter the model. All of these government activities are financed by taxes. Finally, the government sector includes the Caisse de Péréquation (Marketing Board for rice) and the Caisse de Stabilisation (Marketing Board for cocoa, coffee and cotton and the ETAT de education), whose activities are modelled as taxes or subsidies depending upon whether on a net basis revenues are raised.

External Sector

As discussed in Whalley and Yeung (1984), the treatment adopted for the external sector in general equilibrium models is important because it can significantly affect results. The term 'external sector closure rule' refers to the assumptions made on the export demand and import supply behavior of the foreign entity (rest of the world) with whom the country being modelled is assumed to trade.

There are two popular variants of external sector closure used in the literature. The first is the small open price taking economy treatment (SOPTE) with homogeneous goods. In this model variant, import and export prices are taken as given, and hence there are no endogenous changes in the terms of trade as policies or other parameters in the home country change. Commodity trade imbalances are balanced by exogenously specified capital inflows in the current account.

This small open price-taking economy (SOPTE) formulation provides a simple description of the rest of the world. Interdependence with the rest of the world is reflected in the prices faced by the smaller economy. With no insulation from the world economy, world prices determine domestic factor prices and production. The implication of this assumption is that there are no terms-of-trade effects which affect model welfare results. However, because only net trades enter the SOPTE implementation, it cannot account for cross-hauling found in the international trade statistics. Also, because it explicitly assumes infinite elasticity of foreign excess demand functions, sensitivity analysis on trade elasticity parameters is not possible. The SOPTE assumption also becomes key to how the model evaluates the impacts of policy changes. For example, given Côte d'Ivoire's large position

in global cocoa production, this may be an inappropriate, even if a convenient, assumption.

The second external sector closure rule widely used is one based on the so-called Armington (1969) assumption. Under this formulation, imports are treated as imperfect substitutes for domestically produced goods. The supply of imports is often assumed to be perfectly elastic at fixed world prices in this formulation; i.e., the country is a "price taker" on imports, with the country being a "price maker" for exports with the foreign demand function for the country's exports being downward sloping.¹⁵ The Armington assumption, therefore, allows for two-way trade as well as price differences between imported and domestically produced goods. In this formulation, agents are thought of as demanding an aggregate (or composite) of imported and domestic goods. The composition of this good depends on the relative prices of imported and domestic goods, and on the elasticity of substitution in preferences or production specified.

The external sector closure rule we used in the social policy model is a hybrid of the two standard approaches designed to give a convenient and simple treatment, while giving more flexibility than a simple SOPTE treatment. We use the Armington (1969) assumption that imports are imperfect substitutes with domestically produced goods, and so the domestic-import composite enters the intermediate demand and household final demands. However, we depart from the "price taker" on imports and "price maker" on export treatment

¹⁵ This external sector closure rule was used for example in a model of Turkey (Dervis and Robinson 1982), Cameroon (Benjamin and Devarajan 1985). Although as Whalley and Yeung (1984) implicitly point out, in an N good world the restriction of Walras Law on the foreign country excess demands would imply a cross-equation restriction between import supply and export demands such that this treatment could not apply to all members of the two subgroups of goods.

described above in that we assume small open price taking behavior on both imports and exports.

Counterfactual policy analyses can be performed with the model for changes in a variety of social policies, including income and value-added tax changes, targeting programs, and changes in government expenditures (on education, for instance), domestic price controls, export policies, and others. When used in counterfactual mode, the model is solved using the MPS-GE software package developed by Rutherford (1988). This software package explicitly incorporates the optimizing behavior of consumers and firms, together with the activities of central and provincial government agencies. The numerical specification of behavioral relationships and policy parameters in the model are generated using the calibration techniques set out in Mansur and Whalley (1984) using the 1986 SAM referred to above.

The MPS-GE software used captures four sets of economic constraints (for commodities, consumers, producers and auxiliary constraints), and two classes of functions (utility and production functions). Agents are assumed to behave competitively; i.e., consumers allocate their incomes to maximize utility from consumption, producers adjust their production plans to maximize profit, and both groups take market prices as given. The number and types of agents and commodities, together with the characteristics of production and utility functions, constitutes the input formulation of the model for the purposes of MPS-GE. Primal and dual constraints require that supply satisfies demand and that no sector earns excess profit; MPS-GE uses these conditions to compute equilibrium prices and quantities.

Tax Structure

Export taxes and Caisse de Stabilisation (STAB)

Côte d'Ivoire levies export taxes on the traditional and non-traditional exports, which are both captured in the model, even though these have been sharply reduced in recent years.

The Caisse de Stabilization, or STAB, covers traditional exports (cocoa, coffee and cotton) and in practice its operations are designed to dampen the effects of fluctuation of world prices on domestic producers so as to stabilize their incomes. This institutional arrangement is modelled such that when prices for these products are higher than domestic prices, the difference received by the STAB is transferred to the government as a source of revenue. When the world price is lower than the domestic price, then the sectors involved receive subsidies from the STAB.

Income taxes

The model also captures income taxes in Côte d'Ivoire, although in practice they largely affect higher income urban workers and government employees. In the model, household h with income Y^h is taxed at the marginal rate of τ_h . Marginal rates increase with income. The income tax paid by household h (PIT^h) is thus:

$$PIT^h = \tau_h \sum_{k=1}^3 \pi_k \omega_k^h \quad (1)$$

The total income tax revenue received by the government from the household sectors (R^h) is:

$$R^h = \sum_{h=1}^7 PIT^h \quad (2)$$

Taxes on goods and the production value-added tax

Taxes at rate τ_i on household purchases of products also enter the model, reflecting the operation of excises and other commodity-specific taxes. Total revenues from these sources, R^c , is given by

$$R^c = \sum_{i=1}^{15} \sum_{h=1}^7 \tau_i p_i G_i^h \quad (3)$$

The Côte d'Ivoire value-added tax is modelled as applying at rates t_j directly to value-added originating in each sector. Revenues raised from this tax, R^p , are

$$R^p = \sum_{j=1}^{15} t_j VA_j \quad (4)$$

The total tax revenue collected by the government is thus:

$$R^T = R^h + R^c + R^p \quad (5)$$

Besides tax revenues (R^T), total government revenue (R) also includes revenues collected by the Caisse de Péréquation and the Caisse de Stabilisation.

The government spends part of the revenue raised in the model on goods and services, with the remainder either redistributed back to households as transfers (Γ) or retained as government savings (S^g). As with the private sector households in the model, the government has a constant savings share and a utility defined over goods, including inputs into publicly provided services. From the government utility function, we can calculate the corresponding expenditure function, and so in counterfactual equilibria evaluated with the model, we can determine the revenue required to maintain government utility at the benchmark level. Shoven and Whalley (1977) discuss various definitions of equal tax yield which can be used in implementing such an approach. Ballard, Fullerton, Shoven and Whalley (1985) further report on different types of replacement rules used to maintain the government utility at the benchmark level.

III. ANALYZING THE INCIDENCE OF TAXES IN CÔTE D'IVOIRE

Tax Structure in Côte d'Ivoire

One example of the application of the social policy model presented in earlier sections is to the analysis of tax incidence in Côte d'Ivoire. The Ivorian tax system has undergone substantial change in the last three decades. Initially limited in revenue raising capabilities, both government expenditures and revenues grew in the 1960s as commodity exports grew, because of the preeminent role of trade taxes (both export taxes and import duties) in the tax system. But as small scale manufacturing developed, and with urbanization, and the expansion of government employment, personal income taxes (largely on government employees) and corporate taxes (heavily on foreign owned subsidiaries) grew. Indirect taxes also became more important, and today a manufacturing level VAT¹⁶ now operates alongside specific excise taxes on gasoline, tobacco, liquor, and other items as a major government revenue source. Tax incidence in Côte d'Ivoire is, therefore, changing over time.

In general, the Ivorian economy has had an average tax revenue as percentage of GDP greater than the average for Sub-Saharan African economies (Shalizi and Squire 1988). Table 4 reports the changing revenue importance of taxes in Côte d'Ivoire. The tax system has traditionally been strongly biased against exports, with price stabilization policies operating, against the traditional export sectors especially in the mid-1980s. In 1986, export taxes and contributions to the Caisse de Stabilisation provided almost 17 percent total tax

¹⁶ See the more detailed discussion of the VAT in Côte d'Ivoire in Heian and Monson (1987).

collected. Changes aimed at reducing the burden of taxes borne by the export sector have been a major feature of recent reforms. Falling world cocoa prices have also meant that in recent years the Stabilization Fund has subsidized rather than taxed exports.

The present tax system is then a hybrid, seemingly including all the major elements of a typical tax system (income, corporate, sales, etc.), while maintaining features commonly found in other developing economy tax systems¹⁷. As Table 2 indicates, there is a continuing heavy dependence on import duties.¹⁸ Second, the base of each of the major taxes remains narrow (income tax on government employees; corporate tax heavily focused on foreign subsidiaries, VAT restricted to manufacturing level, etc.), which leads to the relatively high tax costs for certain sectors of the economy.¹⁹ Finally, the tax system has been operating in a rapidly changing macro-environment, with large debt service and domestic government arrears, further complicating tax incidence analyses.

¹⁷ See Shah and Whalley (1991)

¹⁸ Export taxes have been sharply reduced throughout the late 1980s.

¹⁹ In 1986, 47 percent of total production tax revenues came from the service sector only.

Table 2

Composition of Tax Revenues in Côte d'Ivoire for Selected Years
(percentage)^a

	1980	1983	1986	1987	1988	1989	1990	1991 ^e
(% of Total Revenue):								
Production taxes	25.6	29.7	27.7	30.7	31.9	33.9	38.5	29.7
Import duties	32.0	30.6	35.9	33.6	34.3	37.8	32.7	43.2
Export taxes	10.5	8.7	11.9	11.8	8.6	3.7	1.5	1.7
Income taxes	32.0	31.1	24.5	24.0	25.2	24.7	27.4	25.3
Tax Revenue as % of GDP	23.0	22.2	20.4	21.5	20.3	19.1	19.4	19.9

a: Does not always add to 100 due to rounding

e: Estimates

Sources: World Bank (1987, 1991); Chamley (1991)

Several features of the Ivorian economy and the tax system important for tax incidence analysis are especially worth noting. One is large interhousehold transfers, typically operating between urban households and rural family members. These imply that taxes usually thought of as being borne by one group of households may have part of their burden transmitted to other households through reduced transfers. A second is the narrow base of key taxes, which implies more specificity in tax incidence than in countries with broadly based taxes, since taxes primarily affect more narrowly defined socio-economic groups (government employees, cocoa farmers, etc.), rather than income ranges. A third is the economy's relationship to the external sector, and the tax implications that follow; with

a significant portion of foreign exchange earnings raised through trade taxes, and in such a protected environment, trade arrangements have large incidence effects.

Incidence of Taxes

As Musgrave (1957) long ago pointed out, there is no unique way to execute tax incidence analyses since the counterfactual needs to be carefully specified. He suggested three different tax incidence concepts: "absolute", "differential" and "budget" incidence. Under absolute tax incidence analysis, the distributional impacts of a tax are examined while keeping public expenditures unchanged with foregone revenues left unfinanced (i.e., neither by expenditure cuts or tax increases). Under budget incidence, equal reductions in taxes and expenditures are considered. In differential incidence analysis, the most widely used of his concepts, the tax being examined is replaced by a yield preserving neutral alternative tax. The counterfactual analyses we perform with our model use this differential incidence concept, as in Shoven and Whalley (1977). We substitute a yield neutral broadly based sales tax for each major component of the tax system such that total real government revenues (and hence expenditures) are kept constant in each of our analyses.²⁰

Table 3 reports tax incidence results for various components of the Côte d'Ivoire tax system using 1986 data and the central case specification of our model. We analyze the effects on the seven household groups in the model, who we rank from richest to poorest.²¹

²⁰ See de Wulf (1975) for a review of tax incidence analysis in developing countries.

²¹ Note, however, that this classification from poor to rich is not identical to what would be used in a more traditional income range tax incidence analysis, since the use of socio-economic criteria rather than income deciles mean that the poor and the rich households in the

For each household group we report welfare impacts by household for the tax change involved, in terms of Hicksian equivalent variations expressed as a fraction of the base case gross income of the household group. A positive number indicates a gain from the tax change, and a negative number a loss from the change from the present tax regime to one containing an equal yield broadly based sales tax in place of the replaced tax.

Table 3

Incidence Impacts of Ivorian Taxes from the Central Case Model Variant
(Hicksian EVs expressed as percentage of benchmark gross income)

Households	Introducing an equal yield, non-distorting consumption tax to replace:					
	Personal income tax	Production taxes	Export tax	Import duties	Stabilization Fund	Subsidies
	1	2	3	4	5	6
Poor ↓						
Food croppers in Savannah	-0.65	-6.44	0.25	0.67	0.46	-3.58
Export croppers	-0.26	4.51	1.12	24.11	27.87	0.86
Small businesses	-1.58	1.24	0.09	-0.18	-1.60	0.22
Other food croppers	-1.52	-7.93	0.04	0.16	-3.03	-3.20
Inactive	2.66	-2.53	0.42	1.12	5.35	-2.79
Government employees	3.44	2.59	-0.61	-8.50	-10.33	1.52
↑ Rich						
Households in formal sector	-0.63	3.48	-0.38	-10.8	-8.73	1.73

economy are distributed across all of these groups. The ranking in Table 5 is only by the mean incomes of each group.

Personal Income Taxes

Our results in Table 3 generally produce a progressive incidence profile for the Ivorian income tax, but not for the top income group in the formal sector where use of tax loopholes and avoidance changes the incidence profile. Other developing country incidence studies using partial equilibrium generally show personal income taxes to be progressive, since these taxes are assumed to be borne by those individuals who pay them. These studies ignore complications stemming from effects on labor migration (urban-rural, for instance) or tax evasion,²² and interhousehold transfers which (as will be shown) can alter the tax incidence profile.

Production (sales, value-added and excise) Taxes

Column 2 in Table 3 presents incidence results for production taxes, finding their incidence profile to be neither progressive nor regressive, with the major effects from removing these taxes operating against the non-export agricultural sector (food croppers in the Savannah, and other food croppers), and with exporters and urban dwellers gaining from the removal of the tax (and its replacement by a yield-neutral alternative). A series of factors account for these results. Food croppers are largely tax free in the base-case situation, and are adversely affected by the broadly based equal-yield tax which they, along with all households, pay. Urban dwellers are heavy payers of the manufacturing level VAT in Côte d'Ivoire.

²² For anecdotal evidence on tax evasion see for example Klitgaard (1988).

These results differ from other incidence analyses of production taxes in developing countries which generally reflect an assumption of full forward shifting. Because these taxes are usually simply allocated among income ranges using data on consumption expenditures, such studies usually find that these taxes are regressive while also arguing that this regressivity could be reduced through the use of differential tax rates by commodity, and excises on "luxury goods".

Here, the incidence profile is a mix of negative and positive effects by household group. Larger redistribution occurs than with the income tax because of the large relative price effects stemming from the removal of selective sales taxes, including the VAT and border tax adjustments.

Export Taxes

Incidence results in Table 3 for export taxes show a pro-poor effect from the removal of export taxes in Côte d'Ivoire, suggesting that these taxes are regressive. Indeed, current tax reforms aim at gradually eliminating these taxes. In part, these incidence effects from the model reflect the impact of the replacement taxes in also applying to urban households consuming imported products. These results are in contrast to those from other incidence studies, which assume that the incidence of export taxes falls exclusively on producer-exporter groups, and which yield a progressive incidence pattern, since these groups are in the higher income ranges. One study consistent with our findings is that of Sri-Lanka by Jayasundera (1986) who also considers implicit subsidies to domestic consumers associated

with export taxes on tea and rubber, and found that these have pro-poor incidence effects.

Import Duties

Results in Table 3 also suggest that incidence effects of import duties in Côte d'Ivoire are large, with mixed effects across household groups ranked by income range. Removing duties positively and substantially affects agricultural export sectors, since import duties operate akin to export taxes. Since prices of domestic import competing products increase behind the tariff wall, removing tariffs raises domestic prices of exportables relative to import substitutes, which affects returns to fixed factors in export sectors. Subsistence food croppers selling food products to the domestic and urban market suffer, as agricultural wages are bid up by agricultural exporters. Government workers lose since they must pay the new replacement tax. In other developing country incidence studies, import duties are usually assumed to be fully forward shifted to consumers of imported products, with a regressive or proportional incidence outcome the standard result (see Jeetun 1978).

Stabilization Payments

Results in Table 3 also reveal incidence effects for the Stabilization Fund covering coffee and cocoa. In part, this is a reflection of the 1986 base-year data used in the model, since in the year large net receipts accrued to the Fund which acted as a tax on export croppers. In the early 1990s, the Fund is close to break-even if not a net payer of revenues, and hence in model terms more like a subsidy. The gain to export croppers from removing the 1986 tax is nearly 30 percent of income. Interestingly, inactive households share in this

gain due to the large interhousehold transfers operating in Côte d'Ivoire. Government employees and households in the formal sector lose due to the introduction of the yield neutral alternative tax which they must pay.²³

Subsidies

The elimination of subsidies, like other experiments considered in Table 3, has a mixed incidence pattern with both positive and negative effects across households. Food croppers tend to lose because of the direct benefits they forgo from agricultural and other subsidies; the inactive lose due to reduced inter-household transfers; and other groups gain due to reduced financing requirements (reflected in a replacement by a yield-neutral broadly based subsidy).

A theme that strongly emerges from these results is that the Ivorian tax system has large redistributive effects, but they criss-cross the rich-poor spectrum of household mean incomes in a number of ways. Removing import duties substantially benefits export croppers while negatively affecting Government employees and formal sector households. These last two groups gain from removing subsidies to the poor due to lowered taxes, and from removing progressive personal income taxes. Low-income food croppers lose from the effective broadening of the VAT base, and the removal of subsidies. And finally, given the 1986 data we use in which the Stabilization Fund appears as a tax, export croppers benefit

²³ Lambert, Schneider and Suwa (1991) also provide evidence that an increase in the receipts of the stabilization fund is distributionally regressive.

from its removal, while higher income groups lose from the equal yield replacement tax introduced in its place.

Thus, positive and negative signs alternately appear in incidence profiles as one moves from mean income poor to rich households. In part, this is because incidence effects by tax, in contrast to developed countries, are more heavily concentrated on particular socio-economic groups, than they are by income range. The importance of the external sector, given high protection is another factor.

Tax Incidence with No Inter-Household Transfers

A further reason for the criss-crossing explained previously, is the role that interhousehold transfers play in determining tax incidence in Côte d'Ivoire. As Table 1 suggests, they are large and as a result taxes thought to be borne by one household group are indirectly borne by others through reduced transfer incomes.

Although our data and model do not capture the full pair wise flows of interhousehold transfers, the net flows (or receipts) we capture are still large enough to affect results. Table 4 reports incidence results for taxes in Côte d'Ivoire where all interhousehold transfers are treated in the model as, instead, being paid directly to the government, so as to remove the direct effects of interhousehold transfers on incidence results.

Compared to Table 3, incidence effects change sign for some household groups, such as the inactive, and the general incidence picture is substantially different for each tax. The mechanism underlying these differences is that payers of transfers are little affected by the model modification, paying transfers in the central case model variant to other households

and in the new model variant to the government. But receivers of transfers, such as the inactive households now receive a larger overall proportional share of government revenues, rather than directly receiving transfers from other households, substantially weakening interhousehold linkage in transfer activity and its influence on tax incidence results. These differences in results between Tables 3 and 4 thus suggest the importance of interhousehold transfers in assessing the incidence of taxes in economies such as Côte d'Ivoire.

Table 4

Incidence Effects of Ivorian Taxes when all Interhousehold Transfers are Eliminated
From The Data and Model
(Hicksian EVs expressed as percentage of benchmark gross income)

Households	Introducing an equal yield non-distorting consumption tax to replace:					
	Personal Income Tax	Production Taxes	Export Tax	Import Duties	Stabili- zation Fund	Subsidies
	1	2	3	4	5	6
Poor ↓						
Food croppers in Savannah	-1.17	-8.06	0.21	0.62	-0.88	-3.97
Export croppers	-0.05	3.99	1.20	24.43	29.43	0.36
Small businesses	-1.63	1.26	0.08	-0.17	-1.40	0.24
Other food croppers	-1.25	-9.00	0.21	0.58	-0.49	-4.39
Inactive	0.16	0.61	0.07	-0.43	-1.36	-0.06
Government employees	4.62	2.10	-0.54	-8.13	-8.92	0.97
Rich ↑						
Households in formal sector	-0.22	2.89	-0.29	-10.38	-7.06	1.06

Sensitivity Analysis

We have also investigated the sensitivity of tax incidence results to model features and parameters, conducting a series of further incidence analyses under a variety of alternative model specifications. One of the interesting set of results is reported in Table 5, for the case where we set all capital labor substitution elasticities equal to 0.5 (see Table B2 in Appendix B for the values used in the central case).²⁴ While these are admittedly relatively small changes in model specification, results in Table 5 show little sensitivity in incidence findings to these elasticity variations. Generally this is the case with other elasticity variations, but for changes in model structure (such as variations in the relative size of fixed to variable factors by industry), more variations can be obtained.

Thus the theme that emerges from these incidence analyses is that mechanical application of partial equilibrium incidence analysis based on shifting assumptions to African economies should only be undertaken with extreme caution. Country-specific features such as interhousehold transfers can substantially affect results; narrowness in tax bases implies concentrated and localized incidence effects which may not be reflected in effects across income ranges; and tax burdens may be transmitted to other groups through changed behavioral patterns.

²⁴ Various changes in substitution elasticities between domestic and foreign products in consumption and production for the removal of imports duties analyzed in Table 3, also show little sensitivity in incidence results.

Table 5

Incidence Analyses of the Incidence of Ivorian Taxes
under Elasticity Sensitivity Analysis for Table 5 Results

(Capital-Labor Substitution Elasticities in all Industries
Set Equal to 0.5)

(Hicksian EVs expressed as percentage of benchmark gross income)

Households	Introducing an equal yield, non-distorting consumption tax to replace:					
	Personal income tax	Production tax	Export tax	Import duties	Stabili- zation Fund	Subsidies
	1	2	3	4	5	6
Food croppers in Savannah	-0.64	-6.41	0.27	0.77	0.56	-3.58
Export croppers	-0.25	4.68	1.18	24.20	28.01	0.87
Small businesses	-1.57	1.32	0.12	-0.06	-1.45	0.23
Other food croppers	-1.50	-7.82	0.08	0.39	-2.76	-3.17
Inactive	2.65	-2.58	0.39	1.01	5.18	-2.82
Government employees	3.40	2.37	-0.71	-8.98	-10.89	1.50
Households in formal sector	-0.62	3.39	-0.40	-10.77	-8.71	1.71

IV. ASSESSING THE EFFECTIVENESS OF ANTI-POVERTY PROGRAMS

This chapter deals with targeting benefits to poor households using the same type of analysis described in the previous chapter. The purpose however is to examine how conventional targeting theory, primarily analyzed in a partial equilibrium framework is modified when applied in a general equilibrium context. We first provide a brief review of existing transfer mechanisms in Côte d'Ivoire, then outline the household sector in the model in terms of the grouping, and the poverty incidence obtained from the functional distributions adopted. The principles of targeting and the derivation of the size of the various targeting programs are also discussed. These calculations are then used for counterfactual analysis using the model and the conventional policy approach is re-examined in light of the results obtained.

Social Transfers in Côte d'Ivoire

Targeting programs, have been extensively used to redistribute income in Côte d'Ivoire.²⁵ They have been a key part of social expenditure programs which represent the highest share of total government expenditure. In 1990 for example, total expenditure on education and health was over 50 percent of total recurrent expenditure, of which 35.6 percent went on education and 6.7 percent went on health. Within the general education budget, the government committed itself to subsidize education expenditures and specifically students' costs such as living expenses, books and other expenditures through direct transfer

²⁵ Targeting programs can include both transfers and price subsidies. The latter, in an extreme form, is equivalent to direct cash transfers. See Besley and Kanbur (1988) and Jesurun-Clements (1992).

schemes; in 1990 transfers totalled 12.5 percent of the education budget (see Table 6). Although educational cash transfers are sector specific and not directly for poverty alleviation purposes, they are for all practical purposes a targeting scheme using education as an indicator.²⁶

Table 6

Structure of Transfers by Education Level
1983, 1990 (CFAF Million)

SECTOR	TRANSFER			
	1983 CFAF Million	%	1990 CFAF Million	%
Primary	4,142	12.6	3,410	13
Secondary	8,298	25.2	8,732	33.5
Higher	14,030	42.7	11,111	42.6
Technical	6,403	19.5	2,835	11.8
Total	32,875	100	26,088	100
% Total Education Budget		17		12.5

Source: World Bank (1987, Vol. II)

Available evidence suggests that the main beneficiaries have been urban students in higher education with award criteria that were never applied, thus creating a less than

²⁶ Whether education transfers have been used explicitly by the Government for alleviating poverty is an important question that is not however addressed in this paper. Besides the distributional implications of the existing transfer scheme, another question is whether education is an efficient indicator for targeting programs to the poor. For a discussion of targeting by indicators see Besley and Kanbur (1988), and Thorbecke and Berrian (1988).

equitable system. The education targeting program also points to the political considerations that need to be taken when evaluating any targeting program. In the context of the education program, the Government has been reluctant to reduce them for fear of alienating the politically sensitive student body.²⁷ Any transfer scheme to reduce poverty will therefore be at the expense of some other government expenditure and this trade-off needs to be accounted for.

Implementing Analysis of Targeting in the Model

Two characteristics of the treatment of households in the model are important for targeting analysis. The first relates to the disaggregation of the household sector and the second relates to measures of poverty incidence and income distribution in the structure adopted.

Apart from considerations mentioned earlier, the choice of household disaggregation is a function of the policy issues addressed whether undertaking tax incidence analysis or assessing targeting programs. As will become apparent, by classifying households according to socio-economic grouping, the type of targeting scheme to be adopted is in large part predetermined. In general, the division of the household sector, using income levels has two major drawback from a targeting perspective. With such a disaggregation, a household's relative position is affected by the policy change since income varies, and it is impossible

²⁷ As Table 8 shows, the total transfer program represented in 1990 12.5 percent of the total education budget. Under a human resources adjustment program the education transfers are projected to fall to 6 percent by 1995 of the operating budget while improving the targeting of these transfers to help the neediest.

to target a specific group. Socio-economic criteria, on the other hand, implicitly assume less mobility between groups, over the short run at least (Pyatt and Round 1976, and World Bank 1990). The second drawback is that such an approach presupposes that groups are identifiable; i.e. for example, one can physically identify the top decile. How to identify households by income level is one of the major constraints for targeting programs; a disaggregation that follows socio-economic criteria incorporates at least some identification of the households. Thus, it is easy to identify households living in the Savannah, or those that work in the traditional export sector, or even those who are government employees.²⁸

Since our targeting analyses are concerned with eliminating poverty, we need to describe the income distribution adopted in the model and how the poverty incidence in turn is derived. The functional distribution used follows Dervis, de Melo, and Robinson (1989). A log-normal distribution is constructed for each household group, with the log-variance obtained exogenously (e.g., household survey), and the arithmetic mean income from the benchmark data set.²⁹ For each policy simulation, the model provides a corresponding mean income,³⁰ and for a given poverty line Z , the z-score is obtained and the poverty

²⁸ The adoption of socio-economic criteria is equivalent to adopting a universal targeting scheme with indicators. This is similar to what Besley and Kanbur (1988) and Thorbecke and Berrian (1988) suggest in order to reduce the leakages of a universalistic transfer scheme.

²⁹ The log-mean is $\mu = \ln(\bar{y}) - \frac{1}{2}\sigma^2$ where y is the arithmetic mean income, μ is the log mean, and σ^2 is the log-variance.

³⁰ The resulting mean income is expressed in 1986 prices.

incidence calculated for each group. Note that since the log-variance is exogenously determined, it remains fixed in the counterfactual analysis.³¹

Table 7 gives the head count ratio for each group and the contribution to total poverty. In general the poverty profile obtained from the model is similar to Kanbur (1990) with some relative differences. The household with the highest poverty incidence is the Savannah household with 63.68 percent of the population living below the poverty line, and contributing to 19 percent of national poverty. The informal household group also has a relatively high poverty incidence while contributing the most to national poverty. Interesting differences with Kanbur (1990) is the high incidence of poverty in the export households 44 percent, compared to 36.5 percent using the 1985 household survey, and for the government household, 3.1 percent in 1985, compared to 8.69 percent in the model.³² In general the model shows that the non-agricultural poor contribute significantly to national poverty (45 percent of total poverty).

³¹The poverty indexes obtained for each group is therefore determined in part by the exogenous log-variance and by the adoption of a log-normal distribution. This has important implications for the size of the targeting program needed to eradicate poverty.

³² It is really not possible to compare both sets of figures since they are based on a different data set, and different methods of calculation, but it does provide an idea of the poverty incidence adopted in the model compared to other studies. For example, the informal and inactive households are more represented in the 1986 survey than in the 1985 data set leading to their higher contribution to poverty [Kanbur (1990), Chia et al. (1991)].

Table 7

Poverty Profile of Household Groups in the Model

Household	Poverty Ratio	Contribution to National Poverty
Export Croppers	44.04	24.03
Food Croppers in the Savannah	63.68	18.89
Other Food Croppers	34.46	11.84
Government Employees	8.69	2.76
Formal Sector	1.79	0.36
Small Businesses	46.81	27.06
Inactive	37.07	15.06
All	37.16	100.00

Principles of Targeting ³³

Over the past decade there has been major debate on the social costs of implementing adjustment programs in developing countries. It has been argued that adjustment policies have led to a deterioration in general welfare and that poor households were severely hit. As a result, a series of actions were recommended to mitigate the effects of adjustment on the poor whether by protecting them from temporary shocks or by increasing their effective

³³ This section draws heavily on Besley and Kanbur (1988).

participation in the recovery programs.³⁴ The use of targeting mechanisms to reach the poor is a natural outcome of this debate and has been the focus of much attention.

Kanbur (1987), Ravallion and Chao (1987), Besley and Kanbur (1988), and Thorbecke and Berrian (1988) provide an extensive discussion of the theoretical basis of targeting. The objective in targeting is to make transfers to poor households such that their income level after the transfers is just above the poverty line. If the income of the households was perfectly measurable and poor households could be identified, the transfer program would target funds to these poor households only. This extreme case called "perfect targeting" (since it assumes that each poor household can be perfectly identified) is represented in Figure 3. If a household is below some poverty line Z , then an amount is transferred to the household such that its new income just equals Z . Any point below the 45° line implies that the household receives a (positive) transfer, and any point above it shows that the household receives a negative transfer, i.e., it is being taxed. The total cost of the poverty reduction program in such a case is simply the area of the triangle OZC .³⁵

The amount needed to finance this program is simply equal to the area OZC . If this transfer scheme is to be self-financed, the same amount must be obtained by taxing other households. This is depicted by the solid line below the 45° line where the households that are above Z are taxed. As mentioned earlier, the use of targeting mechanisms is conditional on the identification of the poor. In this extreme case, the size of the transfer program is based on the assumption that it is possible to identify the poor below the poverty line Z .

³⁴ See for example, Cornia et al. (1987), World Bank (1990b), UNDP (1990).

³⁵ This assumes that the distribution of income is uniform.

The other extreme case ignores the issue of whether one is able to perfectly identify the poor or not, and simply transfer to *all* households an amount that would completely eliminate poverty. Under such a scheme, the total cost would be much larger than under a scheme where transfers are only given to the poor. This "universalistic" program is depicted in Figure 2. The figure shows that to each and every household an amount Z is transferred such that there are no households with an income below Z , which explains why there is a parallel upward shift of the curve to a level Z .

The cost/benefit of both schemes is apparent; in the perfect targeting case total transfers needed to eliminate poverty are less, but there is a cost in identifying the poor that could easily outweigh the benefits from the smaller transfers. Under a universalistic program, total transfers are higher but there is no *a priori* cost of identification.³⁶ From an operational perspective, the perfect targeting scheme is impossible to apply, and Besley and Kanbur (1988) suggest that universalistic schemes are probably more realistic and have indeed been applied.³⁷ But as Thorbecke and Berrian (1988) suggest, an intermediate solution is to use socio-economic indicators that allow policy makers to reduce the size of transfers under a universalistic program.

³⁶ For a more detailed analysis on the cost of identification see Kanbur and Besley (1988). See also World Development Report (1990) for a general discussion on implementation costs.

³⁷ See Anand and Kanbur (1987).

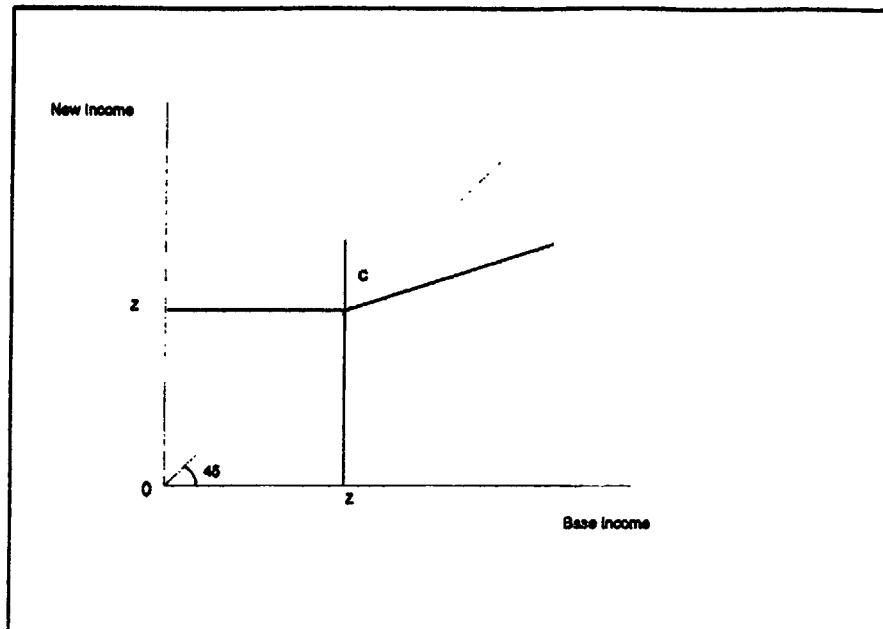


Figure 3. Perfect Targeting Scheme.

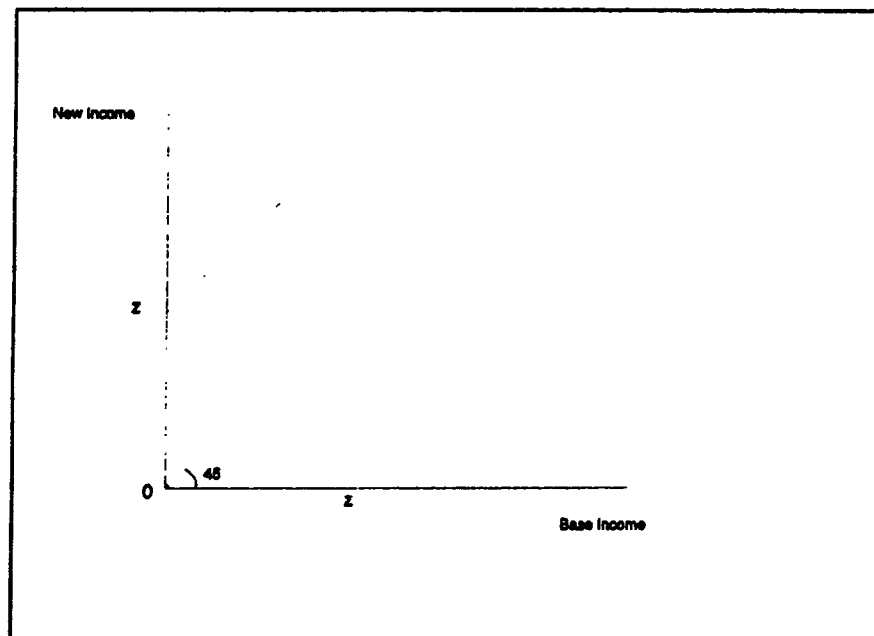


Figure 4. Universal Targeting Scheme.

Source: Besley and Kanbur (1988), World Bank.

The household sector as represented in the model is biased towards a universalistic transfer scheme since there is no distinction between the poor and non-poor in each of the seven groups, so the targeting programs are aimed at socio-economic groups that are easily identifiable.

The calculation of the transfer size can be derived from the Foster et al. (1984) poverty index:

$$P_{\alpha} = \frac{1}{n} \sum_{i=1}^q \left[\frac{z-y_i}{z} \right]^{\alpha} \quad (5)$$

or in terms of the income frequency density function, $f(y)$, such that

$$P_{\alpha} = \int_{\bar{y}}^z \left[\frac{z-y}{z} \right]^{\alpha} f(y) dy \quad (6)$$

where n is total population, q is the number of poor, Z is some pre-determined poverty line, y_i is the income of the poor household i and α is a parameter that measures the depth of poverty.³⁸ In the case of perfect targeting, the amount needed to eliminate poverty is the sum of the difference between the income of the poor and the poverty line Z or

$$T_p = \sum_{i=1}^q (z-y_i) \quad (7)$$

³⁸ The head-count ratio is obtained when $\alpha = 0$; $P_0 = q/n$.

This can easily be derived from P_α . For $\alpha =$

$$P_I = \frac{1}{nz} \sum_{i=1}^n (z - y_i) \quad (8)$$

or,

$$P_I nz = \sum_{i=1}^n [z - y_i] \quad (9)$$

Thus, to calculate the amount of transfer needed to eliminate poverty in a perfect targeting scheme, one multiplies the poverty index P_I by the poverty line and population n . For the universalistic scheme, each household receives an amount equal to the poverty line Z .³⁹

$$T_u = nZ \quad (10)$$

Note also that since the index is decomposable, it is possible to apply it to the various m household groups, such that

$$P_\alpha = \sum_{j=1}^m x_j P_{\alpha_j} \quad (11)$$

where $\sum x_j = 1$.

Table 8 gives total transfers needed to eliminate poverty under a universalistic scheme using the benchmark incidence levels. It is calculated using the log-normal distribution

³⁹ Since $T_u = nZ$, P_I can also be interpreted as the ratio of perfect targeting to universalistic targeting.

adopted for each household group.⁴⁰ What Table 8 shows is that under a universalistic scheme, the transfer program to eradicate total poverty will be beyond the means of the government.⁴¹ In the case of a perfect targeting program, the cost of a poverty-reducing program would represent 3 percent of GDP.

⁴⁰ The size of the transfers are obtained by shifting the function such that the z-score equals -2.5; i.e. the head count ratio equals zero for each group. Note that the size of the transfer program is not equal to T_u because of the log-normality assumption whereas Equation 41 assumes that it is uniformly distributed.

⁴¹ Using T_u to calculate the cost of a universalistic targeting program will give slightly less than 50 percent of GDP. As a comparison, Boetang et al. (1991) calculate the cost of a perfect targeting scheme as well as a universalistic program for Ghana. For the country as a whole, the perfect targeting program amounts to 7 percent of GDP, while the universalistic program amounts to 60 percent of GDP. World Bank (1990c) shows that for Malawi, a perfect targeting program will cost 4 percent of GDP.

Table 8

Total Transfers in the Case of Universal (Imperfect) Targeting
CFAF Million

Household Group	Transfer	
	CFAF (Mill.)	% of Base Income
Export Croppers	760,000	196.1
Food Croppers in the Savannah	421,000	262.9
Other Food Croppers	475,000	167.3
Government Employees	384,000	69.9
Formal Sector	27,300	5.2
Small Businesses	1,380,000	311.3
Inactive	900,000	215.6
TOTAL	4,350,000	

General Equilibrium Analysis of Targeting Programs

Three issues are addressed; what are the general equilibrium effects of implementing a targeting program for poverty reduction? This deals with whether the size of transfers calculated in a partial equilibrium context are able to achieve zero head-count ratios when general effects are included, and helps in turn quantify the leakages of universalistic targeting programs. Related to this issue is a distinction between the schemes when applied to all households simultaneously or to one group only, which can significantly affect the results of the targeting program. The second issue addressed, concerns the size of the transfer program, and whether it makes a difference in poverty reduction targeting programs. Put another way, is the percentage gain in income due to targeting proportional to the transfer? Finally, the political implications of these targeting programs are analyzed.

Quantifying the Leakage Effects of a Universalistic Transfer Program

As Figure 4 shows, targeting programs based on a universalistic scheme would shift the function up by an amount equal to the poverty line Z . Table 8 is used for our counterfactual analysis. Two types of counterfactuals are performed. In the "ALL" case, the transfers are distributed to all households simultaneously. In the second type of counterfactual, each household in turn is targeted and receives a transfer shown in Table 8. In both cases, this transfer as in the tax incidence analysis uses a differential incidence concept where total real government revenues (and hence expenditures) are kept constant. In all the counterfactuals, all households, including those that receive the transfers are taxed.

Household h therefore receives an amount $\Gamma^h(1-t_h)$ where Γ^h and t^h are respectively the transfers received by and the average tax rate for group h .⁴² The percentage change in utility (a measure of real income) and the poverty index resulting from the policy change are presented in Tables 9 and 10. Table 9 shows that in all the cases, the percentage increase in final real income is less than the percentage increase in base income due to the transfer. This is better reflected in Table 10 that translates the relative changes in real income in poverty measurements. The objective of eliminating poverty is evidently not reached.

⁴² By financing the transfer program with a tax imposed on all households including the beneficiaries of the transfers, one captures the same problem of identifying households in targeting programs viz., identifying households as taxpayers (or beneficiaries of tax exemptions). The financing scheme applied here therefore includes the leakages that arise from imposing a tax to finance a transfer program, and assumes that the government is unable to distinguish -- from a tax policy perspective -- those exempted from the scheme because they benefit from the program and those that should be taxed.

Table 9

**Percentage Change in Utility Level from Benchmark
under a Universal Targeting Scheme**

	All	MEXP	MAGS	MVIVA	MADP	MFOR	MIND	MINAC
Export Croppers	33.24	78.51	-12.40	-16.89	7.82	-0.30	-9.39	1.12
Food Croppers in the Savannah	114.86	2.95	233.03	10.18	-6.44	-0.07	-38.61	-24.18
Other Food Croppers	100.27	-11.74	32.87	37.83	-13.30	-1.74	23.35	13.18
Government Employees	-70.82	-24.56	-18.36	-16.01	47.19	-1.92	-33.12	-11.64
Formal Sector	-79.35	-24.37	-13.38	-17.20	-13.79	3.39	-25.13	-6.53
Small Businesses	19.51	-15.93	-18.05	-6.85	-11.85	-1.03	158.91	-17.93
Inactive	58.18	22.42	-46.22	44.09	3.60	1.86	-88.16	59.73

Table 10

Poverty Index (P_j) under a Universalistic Transfer Scheme

	Base Case	ALL	MEXP	M.SAV	MVIVA	MADP	MFOR	MIND	MINAC
Export Croppers	0.44	0.227	0.104	0.536	0.579	0.5	0.443	0.512	0.433
Food Croppers in the Savannah	0.637	0.425	0.614	0.019	0.56	0.684	0.637	0.908	0.749
Other Food Croppers	0.345	0.046	0.433	0.176	0.159	0.444	0.356	0.215	0.264
Government Employees	0.087	0.699	0.176	0.147	0.138	0.026	0.092	0.23	0.121
Formal Sector	0.018	0.67	0.046	0.031	0.036	0.031	0.015	0.051	0.023
Small Businesses	0.468	0.367	0.564	0.579	0.504	0.536	0.476	0.071	0.579
Inactive	0.371	0.159	0.264	0.719	0.195	0.352	0.363	0.997	0.154
TOTAL	0.37	0.301	0.323	0.386	0.356	0.407	0.374	0.428	0.368

Table 9 shows that in the "ALL" scenario when transfers are distributed to all households simultaneously, both government and the formal private sector households lose

in absolute terms from the universal targeting scheme. Table 10 shows that under this scenario, the head-count ratio increases from 8.7 percent to a dramatic 69.9 percent for government households, and increases from 1.8 percent to 67 percent for the formal households.⁴³ For all the other households the poverty index falls. At the national level, the universal transfer program when applied to all households reduces total poverty by 7 percentage points from 37 percent to 30.1 percent. In the traditional calculations, this would have led to a total eradication of poverty.

The results obtained under the "ALL" scenario are driven by the financing scheme imposed. Since the program is self-financed with a neutral effect on the real government budget, the high-income households will pay more than what they receive. At the same time, the results are affected by the inter-household transfers since poor household groups that receive transfers from the high income households would bear part of the tax burden so that the poverty reduction is less than anticipated.⁴⁴ The individual scenarios produce a different pattern. Looking at the figures in Table 10, we see that even when the transfer scheme is applied to each group individually, total poverty for the group is not eliminated. For example, when the MEXP is targeted, poverty for this group is reduced by 76 percent, but there is still a core poverty level of 10 percent of total population in the export sector. The same is true for the other households. The head-count ratio resulting from these

⁴³ World Bank (1990) provides similar results for Malawi. An income transfer program has a significant impact on the poor at the expense of the non-poor. The results do not take into account general equilibrium effects.

⁴⁴ Our simulation results also indicated that the leakage effect will be smaller when the feature of inter-household transfer is taken out from the model.

counterfactuals can be interpreted as a measure of the leakage effect due to relative price changes, as well as the financing of the universal targeting program.⁴⁵

The head count ratio also suggests some *core* poverty within each socio-economic group that cannot be reached and eliminated even with a universal targeting program. From a policy perspective, the results point to the importance of using targeting programs with indicators that can reach the lowest income households within each group since no transfer level can completely eliminate poverty. Table 10 is derived from the earlier tables and shows the individual poverty levels (or hard core poverty) and the indexes as a percentage of base case poverty. For some household groups such as the Savannah food crop households, the targeting scheme eliminates poverty except for 1.9 percent of the population, or 3 percent of the total poor in the Savannah food croppers. The results show that a universalistic targeting scheme implemented in the Savannah region would be quite effective, with minimal leakages. This is less so for the other food crop households living in other regions of Côte d'Ivoire where the post-transfer poverty level is less than half of the base case level. Non-agricultural households are similarly affected; government households for example are left with 8.7 percent of the households below the poverty line which represents less than a third of the total poor of this group in the pre-transfer case.

⁴⁵ Thorbecke and Berrian (1988) develop a generic SAM-based fix-price model to analyze the effects of imposing a targeting program. Because the model assumes fixed prices, there cannot be any relative price effects, and "any exogenous increases in income are converted into greater production rather than higher prices." The model will, therefore, augment the final benefit the households receive. Evidently the results show that this could be quite misleading. They also assume that the targeting program is exogenously determined, e.g. foreign aid, which can also substantially affect the results as we have shown.

Table 11**Identifying Hard Core Poverty after a Universal Targeting Program**

Household Group	Base Case	With Transfer	% of Base Case
Export Croppers	0.44	0.104	23.67
Food Croppers in the Savannah	0.637	0.019	02.98
Other Food Croppers	0.345	0.159	46.09
Government Employees	0.087	0.026	29.89
Formal Sector	0.018	0.015	83.33
Small Businesses	0.468	0.071	15.17
Inactive	0.371	0.154	41.51

What the results show is that universal targeting programs fare better for agricultural households than for non-agricultural households, although within each group there can be wide variations. In general, the analysis points to the importance of developing targeting mechanisms geared towards the hard core of some groups of the population while for other groups, a transfer program such as a universal targeting scheme is sufficient to produce the expected results. In the case where a universal targeting scheme has relatively little effect, the investment needed to develop targeting programs closer to perfect schemes is unavoidable.

The targeting program for individual households also affects the final income of other households through inter-household transfers. In column three of Table 9, targeting the export households only, will yield real increases in income for the Savannah households as well as the inactive households. The number of poor in the Savannah food crop households

falls from 63.7 percent to 61.4 percent, while the poverty index for the inactive households falls by 10.7 percentage points. The reason for these positive effects are due to inter-household transfers that benefit inactive and Savannah households given that the export households are net payers of transfers. A targeting program to reduce poverty in the export sector will have positive externalities on households that receive transfers from the export households, even though they may be taxed to finance the targeting scheme. When the program is targeted to government households, inactive households see their real income increase by 1.86 percent, causing a fall in the poverty index from 37 percent to 35 percent. The same simulation with no interhousehold transfers cause a 1.2 percent fall in real income for inactive households.

A different picture is also obtained, column four of Table 10 shows the effects on poverty of a transfer program to the Savannah households. This time, export and inactive households lose from such a scheme. Real income for the latter households falls by 46.2 percent and by 12.4 percent for the former. This pattern is repeated at various degrees for all the other scenarios. The lesson to be drawn is that universal targeting programs have important feedback effects that are not taken in traditional targeting analysis. No households gain as much as the original increase in income due to the transfer because of the financing required through new taxes. When inter-household transfers are included some households gain less from a targeted program directed at another group. The operational relevance of

these results are significant; if one of the groups cannot easily be identified, it is possible to reduce to some degree its poverty level by targeting another group.⁴⁶

At the national poverty level, a targeting program to *all* households which redistributes income from the high income households to low income households, will have the greatest effect, total poverty falling from 37 percent to 30.1 percent (Table 10). The transfer scheme only to the foodcrop households in the Savannah is not beneficial at the national poverty level and total poverty increases by 1.6 percentage point. A transfer to the government households, will also increase national poverty, whereas targeting programs directed to inactive households, export and foodcrop households will reduce national poverty.⁴⁷ In all these results, the size of the transfers to the various groups is an important issue examined in the following section.

Varying the Size of the Targeting Program

In the previous section, it was shown that the leakage effects were such that under a universal targeting program, it was not possible to fully eliminate poverty. If the level at which poverty could be eliminated under a universalistic scheme has been shown to be insufficient, will higher transfer levels eliminate poverty? But since the size of transfers is

⁴⁶ For example, the inactive households are difficult to identify since they encompass a relatively wide group of people. In such a case, it may be possible to target some other groups on the evidence that there are strong externalities that could benefit the inactive households. This also points to the fact that the overall effect of a targeting program is incorrectly measured, if the feedback effects are not taken into account (over or under-estimated).

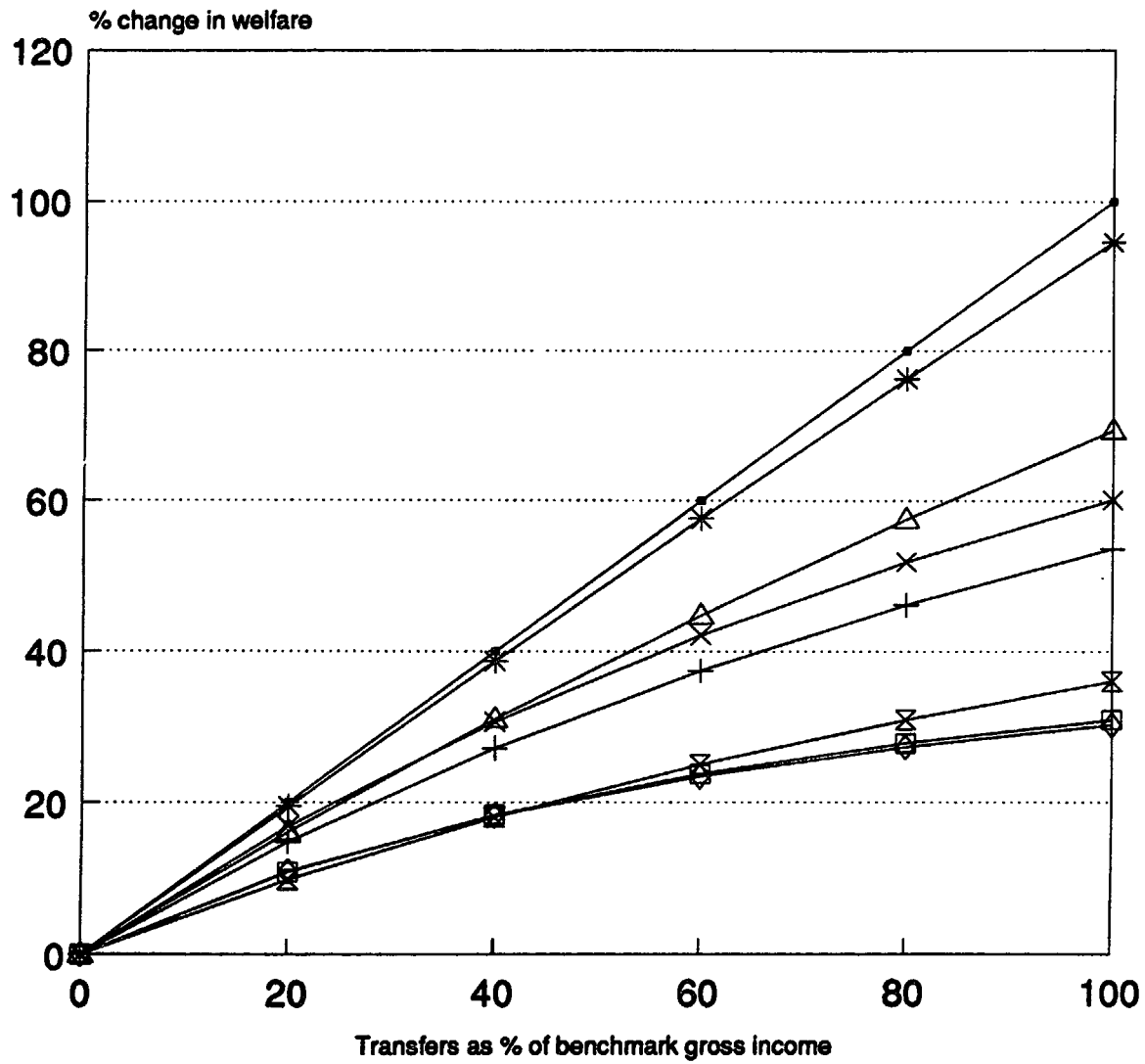
⁴⁷ For a detailed discussion on the optimal distribution of a transfer program that minimizes poverty, see Thorbecke and Berrian (1988).

already high, are the leakage effects similar when transfers are scaled down? Figure 5 shows the percentage change in real income over a range of transfer levels; up to 100 percent of each household benchmark gross income. These graphs are identical to Figures 3 and 4. The 45° line shows that a one percent increase in income leads to a similar increase in (real) income. Any point below the line will show decreasing returns and similarly any point above the 45° line will show an increase in income greater than the percentage increase in transfers.

Figure 5, for example, shows that for most households, small transfers have a greater relative effect than larger transfers. As transfers are gradually increased as a percentage of base income, the leakages are greater. These results are obtained for all households, but at various degrees as indicated by the graphs. In general, leakage effects are smallest for the Savannah households (MAGS) and partial equilibrium analysis does provide a good indicator of the required targeting program. This is because as the poorest households, the Savannah households have the smallest income and hence the smallest tax burden. This contrasts with the other agricultural households where targeting programs have the highest leakages, increasing with the size of the transfer. Ravallion and Chao (1987) obtain similar results, where the percentage gains from targeting are greater the smaller the budget, and Glewwe (1990) also finds similar results from econometric work. The graph clearly indicates that for given poverty objectives, the cost is higher than expected for most of the household groups. As an example, eliminating poverty from government households requires a transfer program equivalent to 33 percent of base income. By including leakages, the results show

that the initial program required to obtain a zero poverty level would have to equal 40 percent of base income; a 21 percent increase in transfers.

Figure 5
Welfare changes with varying levels of
transfer, targeting on each household



—●— 45 line	—+— MEXP	—*— MSAV	—□— MVIVA
—x— MADP	—◇— MFOR	—△— MIND	—x— MINAC

Figure 6 plots the targeting program for the "ALL" case for 17 different levels of transfers. The results reveal that government and formal sector households have negative net gains for all levels of transfers.⁴⁸ To conclude, the size of the transfer greatly matters. Some households benefit, in relative terms, from smaller transfers. Given that this usually occurs at realistic targeting levels, i.e. a small percentage of base income, it is possible to achieve the targets at a lower cost. Put another way, for a given budget one can achieve higher targets than expected.

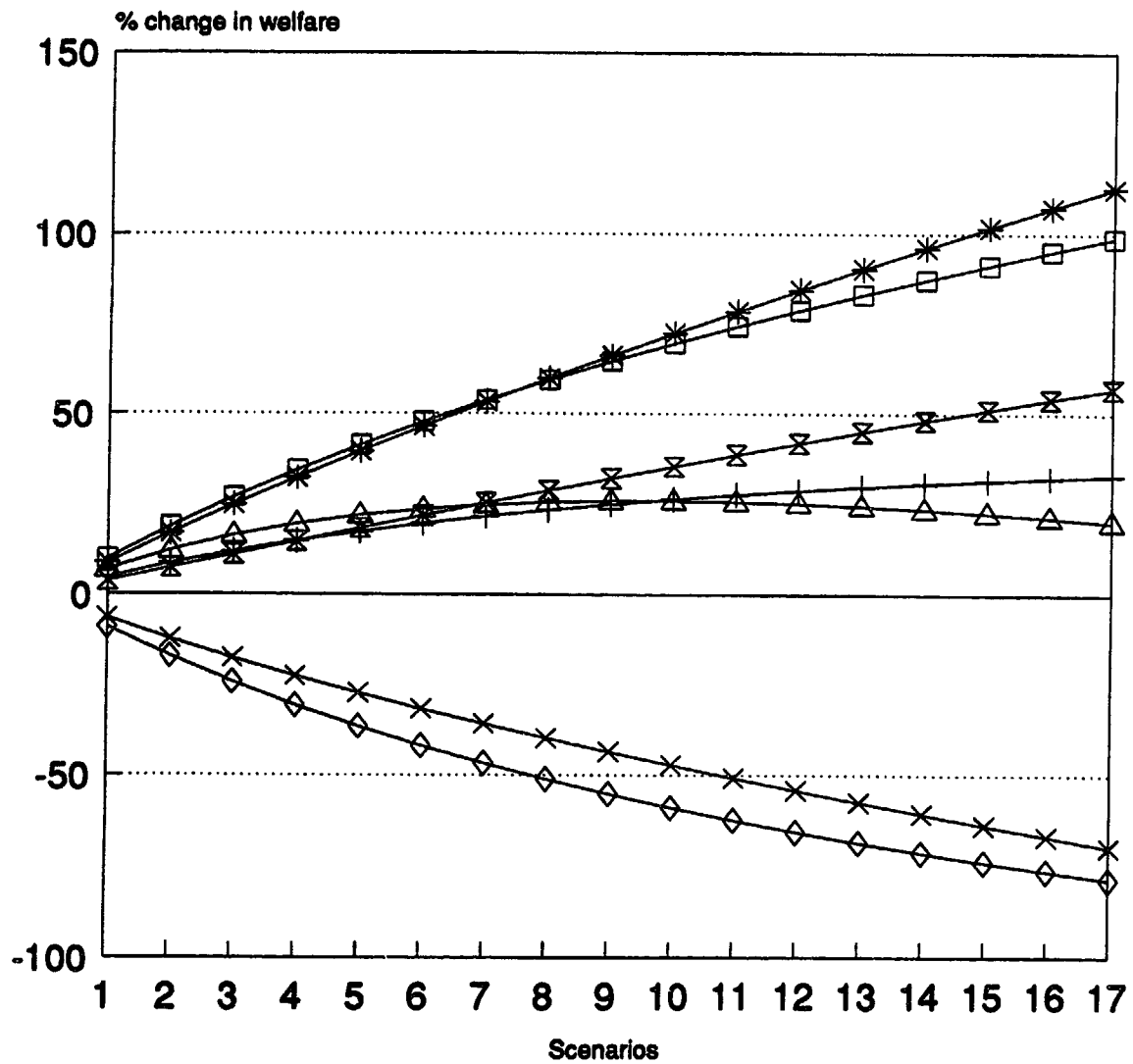
The Political Economy of Targeting Programs

The political feasibility of the targeting programs has largely been ignored in our analysis. However, from a policy perspective, it is of crucial importance especially if the programs face budgetary constraints. In such cases, there is a clear redistribution of income for a fixed level of total income and the high income level groups may not be willing to accept such a program. Besley and Kanbur (1988) suggest that a perfect targeting program may not have enough political weight to be implemented since it will solely benefit the poor probably at the expense of the middle and upper-income groups. The replacement of a universalistic scheme by a more targeted program they argue, would delink the implicit alliance that may exist between the poor and the middle class groups because the latter automatically benefit from a universalistic program.⁴⁹ The results shown in the paper point to a different albeit not contradictory argument. Figure 6 shows that a universal targeting

⁴⁸ Note also that for the informal sector households, the curve is concave.

⁴⁹ See also Murthy et al. (1990) who make the same argument.

Figure 6
Welfare changes with varying transfers
given simultaneously to all households



+	MEXP	*	MSAV	□	MVIVA	×	MADP
◇	MFOR	△	MIND	⊠	MINAC		

program taxed the high income groups (formal and government), irrespective of the level of transfers, so that such a program is undoubtedly politically infeasible. However, this is despite the fact that *within each of the other groups, both low and middle-income households are positively affected*. The export households group for example is made up of low as well as high-income households that benefit from the universalistic target program imposed. The analysis points once more to the importance of dividing the household sector in distinct socio-economic groups that can capture the political feasibility of the various programs. Thus, even though the lower and middle class households in the other groups benefit from the universal targeting scheme, which of the middle class groups affected can determine the political outcome?

V. SUMMARY AND CONCLUSION

This paper reports on a general equilibrium-based social policy model for Côte d'Ivoire detailing its structure, the data used in its implementation, and providing two examples of its application: one to analyze tax incidence, the other to anti-poverty programs. The details of the model are set out in the text above (15 sectors, 7 household groups, CES functional forms), along with the policy configurations it contains.

The model results reporting tax incidence analysis emphasize how special features of the Ivorian economy and tax system are central to any assessment of the distribution consequences of tax and other social policies in Côte d'Ivoire. Because the bases of individual taxes tend to be narrow with a strong sectoral or socioeconomic group focus, incidence effects by socioeconomic group are pronounced, while effects by income range seem to be milder. Urban employees are largely affected by income taxes (through withholding); export food croppers are the groups affected by the stabilization fund and export taxes. In addition, large interhousehold transfers in Côte d'Ivoire change incidence profiles from conventional analysis. This is because taxes seemingly borne by one household group have second-round effects on other household groups through changed interhousehold transfers.

Concerning the targeting programs, the analysis shows that when general equilibrium effects are taken into account, and given a budget neutral targeting program, it is impossible to completely eliminate poverty as it would be suggested under traditional analysis. At the same time, small transfers generally have a greater relative effect than larger targeting programs. This has several policy implications in terms of the actual cost of the programs

and the choice of groups that should benefit from these programs. As in the tax incidence analysis, the paper shows that domestic features such as interhousehold transfers play an important role in determining the final outcome of the targeting program. Finally, the political feasibility of the programs are analyzed, in light of the results obtained from the counterfactual analysis.

The paper should not be seen as directly tied to only enhancing the model structure itself, but rather reflective of an effort to provide input into policy debate and the wider policy process in Côte d'Ivoire. Two aspects of the model need to be mentioned: first, the model should be seen as an instrument that helps in developing capacities for macro-analysis and enhance in general the economic debate. It should be transparent enough to enable policy makers to use it in an efficient way. But the model structure presented in the paper must also be able to answer some key questions that are of relevance to the Ivorian economy. The second aspect is the evident need to move from the traditional general equilibrium model focused on social policy questions as at present, to one where there is more discussion of the treatment of time, and the incorporation of an explicit intertemporal structure, as well as a modeling of exchange rates and money and with them the associated issues of the role Côte d'Ivoire in the Franc Zone. Refinement of existing parameter estimates that have been used in the model, particularly elasticities, is also critical in providing a better representation of the economy.

Overall, our contention is that what has been developed thus far provides a useful and usable social policy framework for Côte d'Ivoire which can generate rich inputs into the Ivorian policy process.

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APPENDIX A

FORMAL MODEL PRESENTATION

Production¹

Two levels of nesting are used. At the top level, producers in sector j use intermediate inputs (A_{ij}, \dots, A_{15j}) and value-added (VA_j) to produce output (Q_j) . A Leontief production function is used which combines intermediate inputs and value added in fixed proportions, implying that there is no substitution between intermediate inputs and value added.

$$Q_j = \min (A_{ij}, \dots, A_{15j}, VA_j) \quad j = 1, \dots, 15 \quad (A1)$$

A Leontief input-output technology is also assumed for intermediate demands. A_{ij} denotes the amount of intermediate input i used in sector j and a_{ij} is the intermediate input-output coefficient. The demands for intermediate inputs by sector j are:

$$A_{ij} = a_{ij} Q_j \quad i = 1, \dots, 15 \quad (A2)$$

This Leontief specification for intermediate inputs implies that demands for intermediate inputs depend only on technology (the a_{ij}) and are independent of prices.

Each intermediate requirement A_{ij} can be met by using a substitutable mix of comparable imported (AM_{ij}) and domestically produced goods (AD_{ij}) represented by a CES function. If σ_{mj} is the elasticity of substitution between AD_{ij} and AM_{ij} ,

¹ Appendix C details the notation used in the equations in this and the other subsections which follow, which together provide a formal presentation of the model.

$$A_{ij} = \varphi_{A_i} \left[\delta_j AD_{ij}^{(\sigma_v-1)/\sigma_v} + (1-\delta_j) AM_{ij}^{(\sigma_v-1)/\sigma_v} \right]^{\sigma_v/(\sigma_v-1)} \quad i=1,\dots,15 \quad j=1,\dots,15 \quad (\text{A3})$$

Industry Value-Added Functions

Value-added in sector j (VA_j), is a CES function of labor (L_j) and variable capital inputs (K_j). Labor and capital are treated as perfectly mobile across sectors, and capital is assumed to be internationally mobile.² If φ_{vj} is the CES function efficiency parameter; δ_{kj} is the distribution parameter in the CES function for factors, and σ_v is the elasticity of substitution between the factors, the CES function is given by:

$$VA_j = \varphi_{vj} \left[\delta_{kj} L_j^{(\sigma_v-1)/\sigma_v} + (1-\delta_{kj}) K_j^{(\sigma_v-1)/\sigma_v} \right]^{\sigma_v/(\sigma_v-1)} \quad j=1,\dots,15 \quad (\text{A4})$$

Demands for Variable Factors

Factor demands are derived from cost-minimizing behavior, given the CES functions above. $\pi_{L_j}^*$ and $\pi_{K_j}^*$ represent the gross-of-tax prices of the inputs L and K respectively

² For the agricultural sector, in addition to variable capital, we also specify specific factors. This is necessary to avoid the problem of specialization, typical in a small open-economy assumption.

in sector j , given the net-of-tax prices, π_L and π_K . If t_{L_j} and t_{K_j} are the tax rates levied on labor and capital in sector j , then

$$\pi_{L_j}^* = \pi_L(1+t_{L_j}) \quad j=1,\dots,15 \quad (\text{A5})$$

$$\pi_{K_j}^* = \pi_K(1+t_{K_j}) \quad j=1,\dots,15 \quad (\text{A6})$$

Producers in sector j obtain their per-unit value-added factor demands by minimizing their after-tax factor cost subject to VA_j equalling unity. The Lagrangean for this problem is:

$$\mathcal{L} = \pi_{L_j}^* L_j + \pi_{K_j}^* K_j + \lambda_j \left[1 - \varphi_j \left(\delta_{K_j} L_j^{(\sigma_j-1)/\sigma_j} + (1-\delta_{K_j}) K_j^{(\sigma_j-1)/\sigma_j} \right)^{\sigma_j/(\sigma_j-1)} \right] \quad j=1,\dots,15 \quad (\text{A7})$$

The first order conditions yield derived demands for L and K in sector j per unit of value-added, represented by f_{L_j} and f_{K_j} respectively:

$$f_{L_j} = \frac{1}{\varphi_j} \left[(1-\delta_{K_j}) \left(\frac{\delta_{K_j} \pi_{K_j}^*}{(1-\delta_{K_j}) \pi_{L_j}^*} \right)^{(1-\sigma_j)} + \delta_{K_j} \right]^{\sigma_j/(1-\sigma_j)} \quad j=1,\dots,15 \quad (\text{A8a})$$

$$f_{kj} = \frac{1}{\varphi_{vj}} \left[\delta_{kj} \left(\frac{(1-\delta_{kj})\pi_{Lj}^*}{\delta_{kj}\pi_{Kj}^*} \right)^{(1-\sigma_v)} + (1-\delta_{kj}) \right]^{\sigma_v/(1-\sigma_v)} \quad j=1,\dots,15 \quad (\text{A8b})$$

Treatment of the Labor Market

The model structure includes a treatment of labor market which is more complete than in other general equilibrium models. There is explicit modeling of labor (see Fig. 1). In the agricultural sector, L is a CES function of agricultural labor (T_{AG}) and a composite of skilled (T_{QA}) and unskilled labor (T_{NQA}). In the non-agricultural formal sectors, L is a CES function of skilled (T_{QA}) and unskilled labor (T_{NQA}). As for the informal sector, it only uses T_{NQA} . This more detailed treatment of the labor markets help to identify the effects of alternative policies on different labor components and capture migration processes when the feature of urban-rural migration is incorporated into the model.

Demand

The demand side of the model reflects government expenditures and demands of the seven household groups. Each of the households has endowments and preferences, with fixed exogenous endowments of labor, capital and sector-specific factors.

The gross income of household h , Y^h , is

$$Y^h = \sum_{k=1}^3 \pi_k \omega_k^h + \alpha_h \Gamma - TP^h + TR^h \quad h=1,\dots,7 \quad (\text{A9})$$

Γ represents total government transfers to households, and α_h denotes the proportion of Γ transferred to household h , and hence $\alpha_h\Gamma$ gives the transfers received by household h . TP^h and TR^h define interhousehold transfers paid and received by h . ω_k^h is household h 's endowment of factor k and π_k is the net-of-tax price received by household h as factor owners. If τ_h is the marginal income tax rate on factor income for household h , then the disposable income for household h is given by:

$$Y_d^h = (1-\tau_h) \sum_{k=1}^3 \pi_k \omega_k^h + \alpha_h \Gamma - TP^h + TR^h \quad h=1,\dots,7 \quad (\text{A10})$$

Household preferences are defined over the 15 composite goods (G_i) defined over comparable domestic and imported products. Figure 2, in the text, provides a schematic representation of the nesting structure used in the household utility functions. There are two levels of nesting in the utility function. U_i^h is a Cobb-Douglas function defined over the composite goods (G_i^h). Different Cobb-Douglas parameters are specified to reflect the different preferences across households. Let γ_i^h be the share of good i in household h 's consumption of G_i ; and $p_i(1+\tau_i)$ be the gross-of-tax price of G_i where τ_i is the consumption tax on G_i .

The utility maximization problem for household h is to

$$\max_{\{G_i^h\}} U_i^h = \sum_{i=1}^{15} \gamma_i^h \log G_i^h \quad h=1,\dots,7 \quad (\text{A11})$$

subject to:

$$\sum_{i=1}^{15} p_i(1+\tau_i)G_i^h = Y_d^h - p_s S^h \quad h=1,\dots,7 \quad (\text{A12})$$

Where $P_s S^h$ represents the saving of household h .

At the lower level in the nesting structure, β_{mi}^h is the CES weighing parameter on GD_i^h and GM_i^h and σ_{mi}^h is the elasticity of substitution between GD_i^h and GM_i^h for household

h . At this level, the budget constraint for household l is:

$$\sum_{i=1}^{15} [p_d GD_i^h + p_m GM_i^h] Y_{id}^h \quad (\text{A13})$$

where Y_{id}^h is the disposable income of household h to be allocated to composite good i , which

is obtained from the top level utility maximization exercise.

At the lower level, each household solves a maximization problem:

$$\begin{aligned} \text{Max}_{\{GD_i^h, GM_i^h\}_{i=1}^{15}} U_2^h &= U_2^h(GD_i^h, GM_i^h) \\ &= \left[\beta_{mi}^h GD_i^{h(\sigma_{mi}^h-1)/\sigma_{mi}^h} + (1-\beta_{mi}^h) GM_i^{h(\sigma_{mi}^h-1)/\sigma_{mi}^h} \right]^{\sigma_{mi}^h/(\sigma_{mi}^h-1)} \end{aligned} \quad (\text{A14})$$

$$p_d GD_i^h + p_m GM_i^h = Y_{id}^h \quad (\text{A15})$$

Solving this yields

$$GD_i^h = \frac{\beta_{mi}^h Y_{id}^h}{p_d^{\sigma_{mi}^h} [\beta_{mi}^h p_d^{1-\sigma_{mi}^h} + (1-\beta_{mi}^h) p_m^{\sigma_{mi}^h}]} \quad (A16)$$

$$GM_i^h = \frac{(1-\beta_{mi}^h) Y_{id}^h}{p_m^{\sigma_{mi}^h} [\beta_{mi}^h p_d^{1-\sigma_{mi}^h} + (1-\beta_{mi}^h) p_m^{\sigma_{mi}^h}]} \quad (A17)$$

Since we use continuous utility functions, market demand functions are also continuous in addition to satisfying Walras' law. Aggregating across households' demands yields market demands.

Savings and Investment

As noted in the text, this is a static model so household savings are not a decision variable, with household h 's saving (S^h) determined as a fixed portion of income. Under the model treatment, savings finance investment with S^h transferred to an investment mutual fund agent who then invests in newly produced capital goods. These expenditures correspond to the investment by all the branches identified in the social accounting matrix. Since these expenditures are financed by household's savings, investments are "savings-driven" in the model.³

³ For a discussion of the implications of various savings and investment closure rules, see Dervis et al. (1989), and Adelman and Robinson (1988).

Equilibrium Conditions in the Model

The model solves for equilibrium product and factor prices, activity levels and tax revenues that satisfy all the equilibrium conditions in the model. These cover demand supply equalities for goods and factors, and zero profit conditions for each sector. These conditions can be represented algebraically as follows:

i. Market clearing for all goods and factors:

$$\sum_{j=1}^{15} f_{kj}^* \leq \bar{N}_k \quad k=1,\dots,3 \quad (\text{A18})$$

$$\sum_{h=1}^7 G_i^h + \sum_{i=1}^{15} a_{ij} Q_j \leq Q_j \quad j=1,\dots,15 \quad (\text{A19})$$

ii. Zero profits conditions in all sectors :

$$(1-t_{pj})\pi_j Q_j = \pi_k (1+t_k) f_{kj}^* + \sum_{i=1}^{15} \pi_i a_{ij} Q_j \quad j=1,\dots,15 \quad (\text{A20})$$

The key properties of equilibrium which follow from these conditions include budget balance for the household and government sectors:

i. Household budget balance:

$$\sum_{i=1}^{15} p_i(1+\tau_i)G_i^h + TP^h = \sum_{k=1}^3 \pi_k \omega_k^h + \alpha_h \Gamma + TR^h - S^h \quad (\text{A21})$$

ii. Government budget balance:

$$\sum_{i=1}^{15} p_i(1+\tau_i)G_i^g + S^g + p_\Gamma \Gamma = R \quad (\text{A22})$$

APPENDIX B**IMPLEMENTING THE MODELLING APPROACH**

We use the counterfactual equilibrium analysis procedure described in Mansur and Whalley (1984) to implement the modelling approach set out above. This approach involves three steps: the construction of base data (a SAM), the calibration of model parameters to the base data, and computation of counterfactual equilibria for the policy or other changes to be analyzed.

Base-Period Data for the Model⁴

The base-period data used for the model are contained in a Social Accounting Matrix (SAM) constructed for the Côte d'Ivoire for 1986.⁵ The sources for and methods of construction of the SAM are documented in Chia, Enoh and Wahba (1991). The basic input data for the SAM were obtained from the National Accounts (République de Côte d'Ivoire, 1990) and other sources such as the Balance of Payments from the Banque de données financières, household survey data, and tax data.

A SAM provides a consistent accounting of the circular flow of incomes and expenditures in an economy for a particular year. Transactions in the economy are represented in matrix form. By convention, entries in any row of the SAM represent revenue sources, and entries in any column represent payments. Thus, each cell in a table

⁴ Also see Dervis, de Melo and Robinson (1989), and Pyatt (1987) for a description of the use of SAMs in model construction.

⁵ The year 1986 was chosen because this is the latest year with a consistent set of national accounts data as well as a household budget survey for Côte d'Ivoire.

reports a payment from a column account to a row account. Each account balances, with incomes exactly equalling expenditures such that the column sums in a SAM equal the corresponding row sums.

There are six main accounts in a SAM: those for factors, institutions, investment, activities, commodities and the rest of the world. Each account can then be further disaggregated to reflect the socio-economic structure of the economy being considered and particular policy modelling needs. For example, factors of production can be identified as different forms of sector-specific capital and different categories of labor (agricultural labor, qualified labor, non-qualified labor, and public administration labor). Households can be classified according to socio-economic status with a distinction made between domestically produced and imported commodities. In the SAM used here, the government sector includes such institutions as the Caisse de Stabilisation and the Caisse de Péréquation.

The SAM as constructed also satisfies the various equilibrium conditions implied by the model structure we use. Aggregate supply of each good equals aggregate demand. Aggregate supply includes both domestic production and imports, while aggregate demand includes both intermediate and final demands. Final demands include private consumption expenditures, government expenditures, capital formation and exports. In addition, industries earn normal economic profits; i.e., total receipts from sales equal total expenditures; total sales include payments for intermediate demands, final demands and net trades; total costs of production include costs of intermediate input, payments to primary factors, net payments to the Caisse de Stabilisation, Caisse de Péréquation, and taxes. Taxes

paid by the production sectors include the production value-added tax, import duties and export taxes.

The base-period equilibrium data set must be micro-consistent and satisfy all equilibrium conditions and properties of the model given in equations (23) to (27): market clearance for all goods and factors; all 15 sectors earn zero profit; budget balance holds for all 7 household groups; and government budget balance. The SAM once constructed thus provides a base-period equilibrium data set, which can be used in the numerical implementation of the general equilibrium model described above, since calibration of the model to the data in the SAM involves base data consistent with the equilibrium structure of the model.

Calibration of Parameters

Calibration of the Côte d'Ivoire model to the 1986 SAM requires the determination of parameter values for the various behavioral functions in the model such that the model reproduces the benchmark data as equilibrium solution.⁶ Calibration of Cobb-Douglas functions is relatively straightforward. Scale parameters in the Cobb-Douglas function can be determined simply from the input shares of factors. However, the procedures used to determine the share and other parameters in the CES functions through calibration are more complex.

⁶ See also the discussion of calibration in Michel and Noël (1984), and especially the modèle de prévision macro-économique used by the planning department in Côte d'Ivoire.

The first step, and following Harberger (1962), is to use a unit's convention to separate the benchmark equilibrium data for the SAM into separate price and quantity observations. For example, by assuming the net-of-tax price of labor to be one in the benchmark equilibrium the quantity of labor demanded by sector i is determined directly by the value-added data on labor use in sector i . With this separation of value observations in the SAM into price and quantity observations complete, model calibration is implemented for the CES functions in the ways described in Mansur and Whalley (1984) using elasticity parameters from a literature search.⁷ The specification used for the central case variant of the model in implementing the calibration procedures is outlined in Table B1. The key elasticity parameters used in the model on the production side for capital-labor and qualified-nonqualified labor substitution are set out in Table B2.

The specifics of how calibration procedures are applied can be illustrated for the parameters of the CES value-added functions in each sector. Consider the CES value-added function in equation (A4) reproduced here:

$$VA_j = \varphi_j \left[\delta_{kj} L_j^{(\sigma_v - 1)/\sigma_v} + (1 - \delta_{kj}) K_j^{(\sigma_v - 1)/\sigma_v} \right]^{\sigma_v / (\sigma_v - 1)} \quad (B1)$$

Producers minimize the cost of providing a unit of value-added by minimizing the Lagrangean; given in equation (A7)

⁷Scale parameters in the Cobb-Douglas function are determined from the input shares of factors.

$$\mathcal{L} = \pi_L \cdot L_j + \pi_K \cdot K_j + \lambda \left[\varphi_y \left(\delta_{kj} L_j^{(\sigma_y-1)/\sigma_y} + (1-\delta_{kj}) K_j^{(\sigma_y-1)/\sigma_y} \right)^{\sigma_y/(\sigma_y-1)} - 1 \right] \quad (\text{B2})$$

Table B1

**Summary of the Specification of the Central Case Variant
of the Model Used in Calibration**

A. PRODUCTION

- fifteen sectors
- nested CES function
- Leontief function of value-added and intermediate demand
- Value-added is CES function of capital and labor
- Intermediate demand is a CES function of domestically produced goods and imported goods
- two categories of capital
- non-agricultural capital - fully mobile
- Sector-specific agricultural capital

- three labor types
- skilled labor
- unskilled labor in agricultural sector
- unskilled labor in non-agricultural sector

B. CONSUMPTION

- seven household types
- CES utility function defined over Armington goods

C. KEY FEATURES

- interhousehold transfers
- small open price-taking economy
- goods distinguished between domestically produced

Table B2

Production-Side Elasticities of Substitution Used in the Côte d'Ivoire Model

Sectors ¹	Elasticity of substitution between capital and labor	Elasticity of substitution between qualified and non-qualified labor
1. Food crop	0.4	0.6
2. Traditional export	0.4	0.6
3. Non-traditional export	0.5	0.6
4. First transformation (F)	0.8	0.4
5. First transformation (I)	0.9	0.8
6. Manufacturing (F)	0.8	0.4
7. Manufacturing (I)	0.9	0.8
8. Gas, electricity	0.8	0.4
9. Construction (F)	0.3	0.4
10. Construction (I)	0.4	0.8
11. Transport	0.5	0.4
12. Financial services	0.8	0.4
13. Services (F)	0.8	0.4
14. Services (I)	0.9	0.8
15. Government services	0.0	0.0

¹F and I denote formal and informal sectors.

The first order conditions with respect to L_j and K_j are given by:

$$\frac{\partial \mathcal{L}}{\partial K_j} = \pi_{K_j}^* + \lambda \varphi_{\gamma} \{ \cdot \}^{1/(\sigma_{\gamma}-1)} (1-\delta_{kj}) K_j^{1/\sigma_{\gamma}} = 0 \quad (\text{B3})$$

and

$$\frac{\partial \mathcal{L}}{\partial L_j} = \pi_{L_j}^* + \lambda \varphi_{\gamma} \{ \cdot \}^{1/(\sigma_{\gamma}-1)} \delta_{kj} L_j^{1/\sigma_{\gamma}} = 0, \quad (\text{B4})$$

where $\{ \cdot \}$ is $\left(\delta_{kj} L_j^{(\sigma_{\gamma}-1)/\sigma_{\gamma}} + (1-\delta_{kj}) K_j^{(\sigma_{\gamma}-1)/\sigma_{\gamma}} \right)$.

Dividing (B3) by (B4):

$$\frac{\pi_{K_j}^*}{\pi_{L_j}^*} = \frac{(1-\delta_{kj}) K_j^{1/\sigma_{\gamma}}}{\delta_{kj} L_j^{-1/\sigma_{\gamma}}} \quad (\text{B5})$$

Rearranging (B5), we can solve for δ_j .

$$\delta_{kj} = \frac{\pi_{L_j}^* L_j^{1/\sigma_{\gamma}} / \pi_{K_j}^* K_j^{1/\sigma_{\gamma}}}{1 + (\pi_{L_j}^* L_j^{1/\sigma_{\gamma}} / \pi_{K_j}^* K_j^{1/\sigma_{\gamma}})} \quad (\text{B6})$$

Using the unit conventions above, all the benchmark net-of-tax factor prices π_L and π_K are set to one. Equation (B6) can then be rewritten

$$\delta_{kj} = \frac{(1+t_{L_j})L_j^{1/\sigma_{vj}}/(1+t_{K_j})K_j^{1/\sigma_{vj}}}{1 + [(1+t_{L_j})L_j^{1/\sigma_{vj}}/(1+t_{K_j})K_j^{1/\sigma_{vj}}]^{1/\sigma_{vj}}} \quad (B7)$$

The unit convention thus implies that the value of factor use equals the number of units of each factor. We therefore obtain L_j and K_j from the social accounting matrix (SAM), and t_{L_j} and t_{K_j} are also computed using the SAM. Given exogenous values of the elasticity of substitution between K_j and L_j (σ_{vj}), all the information required to calculate δ_{kj} from equation (B7) is available.

Once σ_{vj} and δ_{kj} are known for each industry, φ_{vj} can be calculated using the zero profit condition:

$$\pi_{L_j}^* L_j + \pi_{K_j}^* K_j = VA_j \quad (B8)$$

But since π_L and π_K are set to one in the benchmark,

$$\varphi_{vj} = \frac{(1+t_{L_j})L_j + (1+t_{K_j})K_j}{\delta_{kj}L_j^{(\sigma_{vj}-1)/\sigma_{vj}} + (1-\delta_{kj})K_j^{(\sigma_{vj}-1)/\sigma_{vj}}} \quad (B9)$$

Similar procedures can be employed at the other levels of nesting on the production side of the model, and on the demand side to determine parameters of preference functions.

Appendix C**Glossary of Notation Used in Model Description****1. Production**

- Q_j : output of sector j
- A_{ij} : intermediate inputs of good i used by sector j
- AD_{ij} : domestically produced intermediate inputs of good i used by sector j
- AM_{ij} : imported intermediate inputs of good i used by sector j
- σ_{mj} : elasticity of substitution between AD and AM in sector j
- δ_j : distribution parameter in the CES function for intermediate inputs
- a_{ij} : intermediate input-output coefficient defining the requirement of input i per unit output of sector j
- VA_j : value added in sector j
- φ_A : efficiency parameter in VA function for sector j
- δ_{kj} : input intensity of factor k in sector j in VA function
- σ_{vj} : elasticity of substitution between factors k in j th sector
- L_j : labor use in sector j , in service units
- K_j : capital use in sector j , in service units
- f_{kj} : use of the factor k to produce a unit of output in sector j
- $t_{k,j}$: ad valorem tax rate levied on capital in sector j
- $t_{L,j}$: ad valorem tax rate levied on labor in sector j
- π_k : net-of-tax price received by owners of factor k

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